

CROSS-BORDER INTELLECTUAL PROPERTY RIGHTS ENFORCEMENT AND
INTERNATIONAL TECHNOLOGY TRANSFER

By

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To our wonderful Earth, whose beauty and
wonder has kept me fascinated with life.

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This dissertation addresses current topics on the enforcement of intellectual property rights (IPR) across national borders. It also discusses how economic growth via international technology transfer is influenced by foreign patenting and IPR protection.

The first chapter analyzes factors affecting the decision to take enforcement actions against alleged IPR violations abroad that result in the export of infringed goods back into the innovating country. The enforcement mechanism studied is that of investigations afforded by the United States International Trade Commission. Using a large sample of countries in an industry-specific model along with a set of institutional, political, and economic controls, we find evidence that investigations are more frequent in industries that face intense import competition among IPR-protected goods. In addition, greater access to U.S. technology by firms in foreign countries is found to increase case filings. Finally, various factors that influence the extent of violations subsequently affect the use of investigations; these factors include the level of corruption,

the level of patent protection and domestic enforcement, and the implementation of the Trade-related Intellectual Property Rights Agreement (TRIPS).

The second chapter studies the effect of market competition and foreign penetration within the United Kingdom on the extent of IPR court litigation under the U.K. legal system. A large sample of legal proceedings is collected over a period of 20 years and analyzed with industry-specific and country-level economic data. We find that court litigation is more common for industries that face heavy foreign penetration via foreign direct investment and that have foreign affiliates of trans-national corporations.

Tying the effect of IPR protection and enforcement to economic growth, a final chapter explores how IPR protection influences technology transfer by way of foreign patenting, which ultimately affects total factor productivity (TFP) at the country level. This cross-country analysis of both developed and developing countries finds that TFP growth is significantly influenced by costly knowledge spillovers, implying that technology transfer is not automatic, but rather a result of a country's effort.

To conclude, the literature has been relatively sparse in the study of cross-border enforcement of intellectual property rights and its corresponding effects on technology transfer and economic growth. This dissertation contributes to this literature with three distinct empirical essays that attempt to address a number of contemporary concerns.

CHAPTER 1
DETERMINANTS OF CROSS-BORDER INTELLECTUAL PROPERTY RIGHTS
ENFORCEMENT: THE ROLE OF TRADE SANCTIONS

Introduction

The enforcement of intellectual property rights (IPR) across national borders has become increasingly important. Frequently IPR are used to disseminate and protect the development of new technologies, academic knowledge, and artistic works. In the international setting, it has been found that IPR promote technology transfer between countries and promote productivity growth. Thus, by strengthening the legal protection afforded IPR and enforcement of these laws, individual countries can encourage further technology growth via international knowledge transfer. However, the extent to which this occurs depends critically on how innovating firms view the effectiveness of IPR protection. In particular, firms are interested in how costly it is to protect their innovations abroad, which depends on the ability to impose sanctions against those suspected of infringement through various enforcement mechanisms.

Much can be learned about the effectiveness of IPR protection by studying the circumstances that lead firms to take actions to protect their intellectual property. Court litigation is a traditional venue for enforcing IPR. Recent studies have analyzed factors influencing patent litigation in the U.S. Lanjouw and Schankerman (2001) find that the value of a patent, the extent to which patents are used within an industry, and market competitiveness within industries all increase the likelihood of patent litigation. Lanjouw and Lerner (1998) present a stylized model on the propensity to file IPR litigation that is

based on the comparison of the expected benefits and expected costs of taking a case to trial. Their estimation results suggest that firms do indeed hinge their decision to litigate a patent based on expected net benefits. The factors analyzed by these studies provide insights into those that are likely to influence international IPR enforcement, where country characteristics become important determinants in the decision to take enforcement actions. Currently there is virtually no empirical research on the factors that affect the extent to which firms protect their IPR abroad.

Court litigation requires that all parties be subject to the jurisdiction of the presiding court. For example, factories in a number of countries reproduce U.S.-patented pharmaceuticals, and then sell them both at home and abroad at a substantially lower price. Because these factories have little to no physical presence in the U.S., the patent owners often cannot sue in the U.S. Thus, U.S. firms often are unable to use U.S. courts to protect their IPR. Even if they have standing in a foreign country to sue over IPR violation, litigation abroad often gives U.S. firms very limited IPR protection due to corruption and weak IPR laws.

Fortunately, U.S. firms also are able to rely on the U.S. International Trade Commission (USITC) for IPR protection because it can impose trade sanctions on guilty foreign parties. In the past three decades, many firms have used this avenue to protect their IPR. This study examines the determinants of the number of investigations filed for alleged IPR violations using a sample of 78 countries and 7 industries over four time periods spanning 1973 to 2000.

The power of the U.S. International Trade Commission extends beyond issuing trade sanctions for IPR violations. Recent literature on antidumping closely parallels that

of international IPR enforcement in that both address cross-border unfair trade practices.¹ Recent empirical studies have found a positive relationship between industry level imports and the extent of antidumping filings (i.e. Blonigen 2000, Sabry 2000). Knetter and Prusa (2000) analyze the influence of macroeconomic factors on USITC antidumping filings from 1980 to 1998 against four major export countries. They find that exchange rate appreciations as well as U.S. economic downturns have increased antidumping filings. This study builds on this literature by examining the role of trade sanctions in protecting IPR and by studying how country characteristics play a role in USITC case filings.

The ability to impose trade sanctions for IPR violations in foreign countries is an important tool for IPR protection. This allows a U.S. firm to punish firms that export IPR-violating products to the U.S., but offers no protection for product violations that are not exported to the U.S. Thus, U.S. computer firms are more likely to seek trade sanctions against computer firms in a foreign country if there are substantial computer imports from that country. We find considerable support for this hypothesis. Interestingly, since much of the imports in IPR-protected goods to the U.S. are from industrialized countries, trade sanctions tend to protect the U.S. from IPR violations in developed countries.

A number of other factors affect the use of trade sanctions. More complaints are filed against countries where there are more U.S. patents to protect, which suggests a trade-off between greater technology access and more patent violations. In addition,

¹ Blonigen and Prusa (forthcoming) provide a review of the empirical literature on the determinants and effects of anti-dumping. One conclusion is that anti-dumping filing decisions are influenced by market conditions.

evidence suggests that the recent implementation of the Trade-related Aspects of Intellectual Property Rights (TRIPS) agreement contributed to a decline in alleged IPR violations. Finally, various country-specific variables are controlled in the analysis, including the level of corruption and patent protection, and the rate of economic growth.

Enforcement Mechanism

The enforcement of IPR in an international setting is a difficult issue for several reasons. First, IPR laws differ from one country to another. Secondly, similar laws between countries can be interpreted differently such that a violation in one country may not be found in another. Finally, attitudes toward IPR protection differ between countries; for example, a pharmaceutical firm in an innovating country may argue that stronger protection increases incentives for developing further medicines, whereas others may argue that stronger protection overly restricts medication access to those who need but cannot afford it. For these reasons, accurate empirical studies of cross-country IPR enforcement are difficult to construct. This paper helps to fill this gap in the literature.

In this study, we analyze individual cases of intellectual property rights violations filed under Section 337 of the Tariff Act of 1930 and conducted at the United States International Trade Commission (USITC).² The USITC serves as the primary ombudsman for U.S. firms to initiate investigations (against entities in foreign countries) for alleged IPR violations without having to go to court. The enforcement mechanism used by the USITC comes in the form of exclusionary orders imposed to prevent further importation of IPR-violating products, which are enforced by U.S. Customs.

² Section 337 investigations follow the guidelines established by the Tariff Act of 1930; however, modern investigations did not commence until 1972. Section 337 investigations include the alleged infringement of patents, copyrights, trademarks, and industry designs. Industry trade secrets (knowledge held by company employees) also fall into Section 337, though these cases are not very prevalent.

The data reveal that the majority of allegations of IPR violations brought about by U.S. firms are directed toward the major export countries of Japan, Germany, Taiwan, Hong Kong (China), Korea, the United Kingdom, and Canada, four of which are G7 countries. In 1994, these seven countries were the source of 57% of all manufactured imports to the U.S. The data therefore suggest that given an ability to impose trade sanctions on firms that violate IPR, firms in these countries would more likely be targeted.

Framework

Consider the following model: assume that all individuals and firms in Country R have information access to a depreciated stock of U.S. patents, P_R .³ At each time period, a country will utilize information contained in a portion of these patents; we classify the usage of foreign knowledge as P_R^δ ; $\delta > 0$. At any given time, a fraction (θ_R) of these foreign patents are used illegally; $\theta_R \in [0,1]$. This fraction is a function $f(\psi)$ of factors that determine the extent of such infringements. These factors include the level of corruption, business cycles, and the existence and enforcement of IPR laws in a country. Thus, $\theta_R P_R^\delta$ is the total number of foreign violations of U.S. patent stock usage.

One of the central points of this paper is that U.S. firms do not file complaints against every possible case. Instead, firms are hypothesized to file complaints when the present value of expected current and future benefits resulting from filing a complaint exceeds the costs of filing the complaint. Given this, we estimate that only a fraction (α_R) of potential violations are ever pursued by the property right owner; $\alpha_R \in [0,1]$.

³ It is important to use a depreciated patent stock, rather than patent flows or a non-depreciated stock. Patent stocks allow for the value of patents granted from previous years that are still used in production, and a depreciated stock allows for the fact that recent innovations tend to make older patents less valuable.

This fraction is a function $g(\phi)$ of the cost-benefit analysis which firms consider before filing a case. Thus, $\alpha_R \theta_R P_R^\delta$ is the number of U.S. complaints against potential foreign violations. (Note that it is possible that some complaints are filed against innocent parties, and these equations do not address the possibility.)

Combining notation,

$$\alpha_R \theta_R P_R^\delta = g(\phi) f(\psi) P_R^\delta \quad (1-1)$$

Assuming a log-linear functional form, the incidence of cases filed against region R can be estimated in the following specification:

$$\ln(\alpha_R \theta_R P_R^\delta) = \beta_0 + \beta_1 \ln(\phi) + \beta_2 \ln(\psi) + \delta \ln(P_R) + \varepsilon_R \quad (1-2)$$

where ε_R captures either variables not controlled in the model or noise in the relationship.

The empirical section of this paper estimates Equation (1-2) using variables representing ϕ , ψ , and P_R . The coefficients represent the strength of various political, institutional, and economic factors that contribute to the propensity to violate IPR or to file a claim for IPR violation. In the following we first address the factors that affect ψ , the propensity to infringe a foreign patent in a country.

A recent policy debate questioned whether adopting more uniform standards of IPR protection decreases the number of violations. In the past few decades, many countries have intensified their efforts to create tough universal standards of IPR protection, primarily due to the dynamic growth of “intellectual goods,” which are costly to create but easily reproduced. The only recent comprehensive agreement was the Trade-related Aspects of Intellectual Property Rights (TRIPS) of 1994,⁴ which calls for

⁴ TRIPS officially went into force on January 1, 1995, but an agreement between the WIPO and WTO calling for cooperation in the implementation of TRIPS did not take effect until January 1, 1996.

the phase-in of stronger protection and enforcement of IPR, particularly in developing countries. It also encourages countries to recognize IPR of member countries and to enforce them in a uniform manner. And finally, as a mechanism to ensure the compliance of TRIPS, the WTO established a dispute settlement procedure to hear complaints between member countries. Thus the TRIPS agreement is expected to reduce IPR violations and to offer another avenue for IPR enforcement, both of which should reduce the number of USITC investigations. We test this with a binary variable indicating the period in which TRIPS has been in existence.

As the discussion of international IPR protection and its economic effects intensified over the past decade, several prominent indices that measure IPR strength across countries have been created.⁵ Rapp and Rozek (1990) developed an index, based on surveys of business and government officials, that accounts for a country's conformity to minimum standards of IPR protection as established by the US Chamber of Commerce. Maskus and Penubarti (1995) updated this index by using predicted values to deal with measurement error due to the subjective components of the previous index. Finally, Ginarte and Park (1997) developed a highly objective index that was the first to incorporate the existence of "enforcement mechanisms" in a country-- for example, the availability of preliminary injunctions.⁶ In our model, we test whether the Ginarte-Park index accounts for differences in IPR protection that would influence the extent of

⁵ Maskus (2000) provides an informative survey of the IPR literature produced to this point.

⁶ The use of these indices has been common in several prominent studies. Eaton and Kortum (1996) find that the propensity to file for IPR protection in a country is highly correlated with IPR strength as measured by the Maskus-Penubarti index. In a survey of multi-national corporations, Lee and Mansfield (1996) find that firms are less likely to transfer their newest technologies via FDI to countries they perceive as having weak IPR protection. Maskus and Penubarti (1995) find that firms are reluctant to export their latest knowledge-intensive goods to countries where there exists a significant risk of IPR violation.

potential violations and subsequently alleged violations. We use the Ginarte-Park index because it is the most recent and complete; furthermore, it contains 5-year ratings over the entire period of the present study.

Another approach to estimating IPR enforcement is to take into account a country's general legal environment. If a government tends to be corrupt, or does not prosecute ordinary crimes within its own country effectively, it is likely that the prosecution of IPR violations within its borders is also lax. The use of corruption indicators would indirectly account for a government's enforcement of its laws governing IPR, and therefore serve as a proxy for the effectiveness of their enforcement within a country. As a result, as corruption levels increase, alleged IPR violations should correspondingly rise.

The state of the economy is another stimulus for filing IPR investigations. From a complainant's standpoint, a slow economy may lead firms to file complaints (sometimes frivolous ones) to potentially limit competitive imports and regain market share.⁷ From a respondent's standpoint, an economic slowdown may lead certain firms to skirt IPR laws in order to maintain economic vitality. Black markets grow as people find cheaper alternatives to licensed goods. Economic downturns are therefore hypothesized to result in more alleged IPR violations.

Next, we look at factors that influence ϕ , the likelihood of a firm to file a complaint. The predominant factor here is the availability of sanctions that firms can pursue against suspected firms, which under USITC rules is limited to the restriction of imports from violating firms. Therefore, we focus on the value of industry-specific

⁷ There is also the possibility of retaliation against domestic exports, though further data is needed to support this point.

import flows from the respondent country to the complainant country. As imports rise, it is more likely that foreign respondent firms within corresponding industries have imports that can be blocked from entry, thus raising the likelihood of filing for alleged IPR infringement. Furthermore, as imports increase within a firm's industry, market competitiveness may drive firms to take actions in order to secure domestic market share.

Another argument, arising from the antidumping literature, is whether firms respond to the level of imports itself or to changes in the level of imports. By estimating the effect of import growth, it is possible to determine whether increases in industry imports would induce a response by firms to take greater actions.

Finally, a measure of the patent stock (P_R) is included to account for the pool from which IPR infringements can occur. It is important to note here that only the patent stock is used, even though the analysis also includes cases of trademark and copyright violations. However, based on the data, 83% of all cases filed involved an alleged patent violation; therefore we use the patent stock exclusively for data consistency. The inclusion of the patent stock measure allows for the effect of greater *access* to technology, which is likely to result in more cases of infringement.

Data

This study uses a comprehensive data set provided by the U.S. International Trade Commission. Since the inception of modern Section 337 cases in 1972, 460 individual cases of alleged intellectual property rights violations have been filed by U.S. firms against foreign entities. In this paper, we use data from 1973 to 2000.⁸ Most case filings

⁸ Because investigations began in 1972, it does not contain a full year of data and therefore we omit this year. We also omit 2001 data because many of these cases are still pending.

involve more than one respondent firm, often located in more than one country. On average, each case involves 6.3 respondent firms, located in 1.4 countries.

Table 1-1 provides an annual count of case filings, respondent country cases, and respondent firms. A case filing is defined as a complaint filed by a U.S. firm against a set of accused respondents. A respondent country case is defined as a set of firms within a single country named in an investigation, without regard to the actual number of firms named. A respondent firm is defined as a single firm named in an investigation. Therefore, if a case is filed by a U.S. firm against 16 respondents, 4 of which are located in country A, 4 in country B, and 8 in country C, then we would count this as 1 case filing, 3 respondent country cases, and 16 respondent firms. Table 1-2 shows the total number of filings by case and total number of respondent firms for each country in the sample; it is clear that most cases are filed against major U.S. trading partners. In Table 1-3, case filings are categorized according to the industry classification of the good in question, as well as the aggregate success rate of cases.

Table 1-1: Annual number of cases, respondent countries and firms

	Cases	Country Cases	Firms		Cases	Country Cases	Firms
2000	17	21	41	1985	25	30	121
1999	9	10	27	1984	33	41	260
1998	11	22	85	1983	43	55	331
1997	13	17	49	1982	23	29	156
1996	13	17	59	1981	18	26	237
1995	11	14	49	1980	18	21	73
1994	6	7	37	1979	15	21	174
1993	17	29	123	1978	22	29	80
1992	13	15	64	1977	11	19	162
1991	11	16	52	1976	7	12	53
1990	13	16	40	1975	5	5	24
1989	19	28	87	1974	9	11	28
1988	11	13	82	1973	4	4	9
1987	18	34	112				
1986	24	39	176	TOT	439	601	2791

Note: Data from 2001 and 1972 are not included because they are not used in the analysis.

Table 1-2: Respondent country cases and firms by country

Country			Country			Country		
Country	Cases	Firms	Country	Cases	Firms	Country	Cases	Firms
Angola	1	5	Argentina	0	0	Australia	3	8
Austria	4	12	Bangladesh	0	0	Belgium	3	6
Bolivia	0	0	Botswana	0	0	Brazil	5	16
Bulgaria	0	0	Cameroon	0	0	Canada	42	202
Chile	1	6	China	15	58	Colombia	1	4
Costa Rica	0	0	Czech Rep.	2	3	Denmark	7	19
Ecuador	0	0	Egypt	0	0	El Salvador	0	0
Finland	6	17	France	15	41	Germany	47	160
Ghana	0	0	Greece	1	3	Guatemala	0	0
Honduras	1	5	Hong Kong	46	230	Hungary	0	0
Iceland	0	0	India	0	0	Indonesia	0	0
Ireland	1	4	Israel	12	30	Italy	12	30
Ivory Coast	0	0	Jamaica	0	0	Japan	107	511
Jordan	0	0	Kenya	0	0	Korea	41	308
Luxembourg	1	3	Malawi	0	0	Malaysia	2	4
Mexico	7	29	Morocco	0	0	Netherlands	18	47
New Zealand	1	2	Nicaragua	0	0	Nigeria	0	0
Norway	0	0	Pakistan	0	0	Panama	0	0
Paraguay	0	0	Peru	0	0	Philippines	6	17
Poland	1	1	Portugal	1	2	Romania	0	0
Russia	0	0	Senegal	0	0	Singapore	10	20
South Africa	2	13	Spain	8	42	Sweden	10	36
Switzerland	12	27	Taiwan	118	776	Tanzania	0	0
Thailand	3	7	Tunisia	0	0	Turkey	0	0
Uganda	0	0	U. Kingdom	27	85	Uruguay	1	2
Venezuela	0	0	Zambia	0	0	Zimbabwe	0	0
TOTAL							601	2791

Note: In this paper, Hong Kong is separated from China for the reason that the majority of data is prior to 1997. Russia includes data from the former Soviet Union. Czech Republic includes data from the former Czechoslovakia.

Table 1-3: Industrial classification of cases

Category	SIC Code	Total Cases	Success Rate
1	Miscellaneous Manufactures	66	54/66 = 82%
2	2800-2899 (Chemicals/Pharmaceuticals)	43	26/43 = 60%
3	3000-3399 (Non-Metal Manufactures)	53	40/53 = 75%
4	3400-3599 (Metals/Machinery)	110	79/110 = 72%
5	3571-73, 3661, 3674 (Computer Goods)	47	41/47 = 87%
6	3600-3699 (Electrical Goods)	81	62/81 = 77%
7	38 (Laboratory/Medical Supplies)	39	26/39 = 67%
Total	All Goods	439	328/439 = 75%

Note: Success rate includes cases that concluded with parties entering into a settlement or consent agreement, or concluded with a court verdict of an IPR violation.

The corruption data come from two well-known sources: *The International Country Risk Group (ICRG)* and *Transparency International (TI)*, both of which are based on surveys of industry experts. The ratings range from 0 to 6 and 0 to 10, respectively, with higher numbers indicating lower levels of corruption. The ICRG is an annual index available from 1983 to 1998, and TI is an annual index from 1996 to 1999 with multi-year rankings from 1980 to 1995. Because both sources are respected and independent of each other, we create a new index, giving each source equal weight. This is done by multiplying the ICRG score by $5/6$ and the TI score by $1/2$, then summing to give a maximum of 10. Finally, to simplify interpretation, the new score is subtracted from 10, which allows higher numbers to indicate higher levels of corruption.

This study examines investigations filed solely by U.S. firms; therefore, the patent stock measure is the U.S. patent stock in a foreign country. Detailed bilateral data on the number of annual patent applications are available from the World Intellectual Property Organization (WIPO) for the entire period. Using these data, a depreciated U.S. patent stock is formed using the 15% discount rate commonly used in these cases (see Griliches (1979) and Coe and Helpman (1995) for methodology on building stocks from annual flow data).

GDP growth data are obtained from *Datastream* and the *World Development Indicators Database*, which provide annual estimates from 1970 to the present. Import data are obtained from Feenstra and the UNCTAD/WTO database. The Feenstra data set contains 4 digit Standard Industrial Classification (SIC) unilateral U.S. imports in current U.S. dollars. Data are available from 1972 to 1994. For trade data after 1994, the

UNCTAD/WTO database is used. All trade data are corrected to reflect real U.S. dollars by the use of a deflator (1985=1).

Empirical Model

This paper estimates the model described in the previous section using industry and country-panel regressions. Data used in the empirical model are classified into corresponding groupings. First, a sample of 78 countries is selected based on the condition of complete availability of the country-specific variables used. This does not result in the loss of any country named in a USITC claim. Of this sample, 39 countries have at least one case filed against them. Secondly, cases and their corresponding respondent firms are classified according to the SIC code of the product involved, then grouped into seven standard industrial categories (similar to those for previous industry studies). Finally, cases and their corresponding respondent firms are placed into one of four 7-year intervals according to the date on which the initial Section 337 application was submitted. This approach allows one to take advantage of changes in variables over time while allowing for minor aggregation of data to minimize noise by reducing the number of observations with a value of zero. Table 1-4 contains specific details on all sample groupings. In total, we have 2184 observations (78 countries x 7 industries x 4 periods) for empirical work.

In this study three estimation techniques are used to explain the likelihood and extent of U.S.-filed allegations for IPR violations abroad under Section 337. Table 1-5 shows the frequency of investigations filed. A characteristic of the dependent variable is that most observations have a value of zero. In our data, of the 2184 observations, 1909 (87%) have a value of zero. The Probit model is appropriate in this circumstance to

estimate whether an observation contains any cases.⁹ To explain the actual number of cases filed, we use standard ordinary least squares as well as negative binomial regression, a type of random effects Poisson. Table 1-5 shows that few cells have more than four country cases.

Table 1-4: Description of sample groupings

Time Interval: 7-year periods: 1973 to 1979, 1980 to 1986, 1987 to 1993, 1994 to 2000

Country List: 78 countries

Angola	Argentina	Australia	Austria	Bangladesh	Belgium
Bolivia	Botswana	Brazil	Bulgaria	Cameroon	Canada
Chile	China	Colombia	Costa Rica	Czech Rep.	Denmark
Ecuador	Egypt	El Salvador	Finland	France	Germany
Ghana	Greece	Guatemala	Honduras	Hong Kong	Hungary
Iceland	India	Indonesia	Ireland	Israel	Italy
Ivory Coast	Jamaica	Japan	Jordan	Kenya	Korea
Luxembourg	Malawi	Malaysia	Mexico	Morocco	Netherlands
New Zealand	Nicaragua	Nigeria	Norway	Pakistan	Panama
Paraguay	Peru	Philippines	Poland	Portugal	Romania
Russia	Senegal	Singapore	South Africa	Spain	Sweden
Switzerland	Taiwan	Tanzania	Thailand	Tunisia	Turkey
Uganda	U. Kingdom	Uruguay	Venezuela	Zambia	Zimbabwe

Industrial Categories (according to SIC codes)

Category	SIC Range	Description
1	2000-2799, 3700-3799, 3900-3999	Miscellaneous Manufactures
2	2800-2899	Chemicals/Pharmaceuticals
3	3000-3399	Non-Metal Manufactures
4	3400-3599	Metals/Machines
5	3571-3573, 3661, 3674	Computer-Related Goods
6	3600-3699	Electrical Goods
7	3800-3899	Lab/Medical Supplies

Notes: For industrial categories, only “manufactured” goods are included: SIC Codes 2000-3999. Agriculture goods, food products, and services are not included because their trade accounts for less than one percent of aggregate world trade. SIC codes 3571 to 3573 are dropped from category four, and placed separately in category five. These codes correspond to computer related hardware equipment. SIC codes 3661 and 3674 are dropped from category six, and placed separately in category five. These codes correspond to semiconductor and other computer related electrical goods.

⁹ A difference between this approach and that of Lanjouw and Schankerman (2001) is this model estimates the existence of at least one case in a specified grouping whereas the latter estimated the existence of litigated patents against a control set of non-litigated patents. Given the differences in data, the approach used in this paper facilitates the estimation of cross-country data.

Table 1-5: Frequency of observations with number of case filings

# Country Cases	Frequency	% of Obs.	# Respondent Firms	Frequency	% of Obs.
0	1910	87	0	1910	87
1	159	7	1	20	1
2	49	3	2	59	3
3	19	2	3	37	2
4	19	1	4	24	1
5	10	1	5	27	1
6-10	16	2	6-10	42	2
11-20	1	0	11-20	29	1
21-50	1	0	21-50	30	1
>50	0	0	>50	6	0

The use of Poisson regression is effective when handling count data where the mean value is near zero while allowing for the estimation of values greater than one, unlike Probit regressions. A drawback to using Poisson regression is the failure to handle over-dispersion in counts. Using a negative binomial regression corrects for this problem of extra variation in the Poisson process. Each of these techniques is used to explain the number of respondent country cases (regardless of the number of firms within each country case) and the total number of respondent firms named in the investigations within the country panel.

The time period involved is 1973 to 2000 according to the sample groupings specified earlier. The full specification equations follow those of Equation (1-2). For clarification, $\alpha_R \theta_R P_R^{\delta}$ is renamed as CASE, and include subscripts for Country (i), Industry (j), and Time (t):

$$\ln(\text{CASE-N}_{ijt}) = \alpha_0 + \alpha_j + \alpha_1 \ln(\Delta \text{GDP}_{it}) + \alpha_2 \ln(\text{IND-IMP}_{ijt}) + \alpha_3 \ln(\text{CORRUPT}_{it}) + \alpha_4 (\text{TRIPS}_t) + \alpha_5 \ln(\text{PATENT}_{it}) + \varepsilon_{ijt} \quad (1-3)$$

where $N = (1, 2, 3)$. CASE-1_{ijt} measures the existence of a case (1 = yes and 0 = no) regardless of the number of accused firms. CASE-2_{ijt} measures the number of respondent country cases from Country i in Industry j in Term t. CASE-3_{ijt} measures the number of

respondent firms from Country i in Industry j in Term t . Independent variables include ΔGNP_{it} , the average real GDP growth rate for Country i in Term t ; IND-IMP_{ijt} , the value of imports from Industry j in Country i in Term t ; TOT-IMP_{it} , the total value of imports from Country i in Term t ; CORRUPT_{it} , the indexed state of corruption in Country i in Term t ; TRIPS_t , a binary variable to indicate the existence of the TRIPS agreement; and PATENT_{it} , the total depreciated number of U.S. patents in Country i in Time t , and e_{ijt} is a random error term. In separate tests, the robustness of industry imports is tested by including total imports from all industries. Next, industry imports is replaced with industry import growth in order to capture the response of firms to changes in import patterns. To add another measure of IPR protection, GINARTE-PARK_{it} is tested with CORRUPT_{it} to capture differences between corruption and patent-protection measures. Finally, industry dummies (α_j) are included in all regressions, and country dummies are included in select regressions. Country fixed effects are added with caution under the uncertainty whether collinearity exists with other variables.

Empirical Results

Estimation results for each modeling technique are reported in Tables 1-7, 1-8, and 1-9. Summary statistics are shown in Table 1-6. Probit estimation results are shown in Table 1-7. These results show the likelihood that an industry category within a country will contain at least one investigation over a fixed 7-year time period. Regression 7.1 is the baseline regression taken from Equation (1-3). In Regression 7.2, the value of total imports is included with industry imports, and these variables are replaced with industry import growth in Regression 7.3. Alternative variables are used in Regressions 7.4 and

7.5 to capture the effect of a country's level of corruption and patent enforcement, and Regression 7.6 adds country fixed effects to the baseline regression.

Tables 1-8 and 1-9 are identical in specification with the exception that the dependent variable is the number of respondent country cases in the former and the number of respondent firms in the latter. Single equation OLS results are shown in Regressions 8.1 to 8.4 and 9.1 to 9.4. Regressions 8.1 and 9.1 are baseline equations; total imports are included with industry imports in Regressions 8.2 and 9.2, and are replaced with industry import growth in Regressions 8.3 and 9.3. Country fixed effects are added to the baseline regression in Regressions 8.4 and 9.4. Negative binomial results for the number of respondent countries and firms are shown in Regressions 8.5 to 8.7 and 9.5 to 9.7. These regressions use the same variables as the OLS regressions except that total imports is not included in a separate test. Using a likelihood ratio test for overdispersion, all regressions show very high chi-square values, thereby warranting the use of the negative binomial regression instead of Poisson regression.

Overall, key variables generally reveal the expected sign. The magnitudes of factors that directly influence a firm's propensity of filing an investigation (ϕ) exceed those that affect the number of potential IPR violations (ψ). This suggests that unless a firm can justify filing an investigation, it generally does not engage in such actions. This implication reflects that which is found in the antidumping literature, where the evidence resoundingly supports the same argument for the filing of antidumping investigations. Individual effects are discussed as follows.

A consistent and significant result for IND-IMP (the value of industry, country, and time-specific imports) in the Probit, OLS, and negative binomial regressions provides

Table 1-6: Variable definitions and summary statistics
Country Panel (78 countries, 7 industries, 4 time periods)

Variable	Description	Mean	StDev	Min	Max
CASE-1	Binomial variable representing the existence of a case (1 = yes) within Country i, Industry j in Time t	0.13	0.33	0	1
CASE-2	# countries listed as respondents in cases in Country i, Industry j in Time t	0.28	1.08	0	23
CASE-3	# firms listed as respondents of cases in Country i, Industry j in Time t	1.28	7.31	0	165
W-CASE-2	Case-2 weighted by size of complainant, using a 1-10 size scale	1.00	4.19	0	95
W-CASE-3	Case-3 weighted by size of complainant, using a 1-10 size scale	4.54	26.94	0	682
Δ GDP	Real GDP % growth rate in Country i in Time t	3.45	2.76	-5.31	15.24
CORRUPT	Composite TI and ICRG corruption index in Country i in Time t (0 = least to 10 = most corrupt)	4.51	2.43	0.34	9.91
GINARTE-PARK	Index of Patent Protection by Ginarte and Park (0 = least protection to 5 = most protection)	2.50	0.89	0	4.24
IND-IMP	Value of imports from Country i, Industry j, to the U.S. in Time t (in constant 1985 \$ billions)	2.89	10.62	0	174.52
IND-IMP GROWTH	Average percentage growth in imports (1=100%) from Country i, Industry j, to the U.S. in Time t	1.32	5.95	-1.00	151.67
TOT-IMP	Total value of imports from Country i to the U.S. in Time t (in constant \$ billions)	20.22	57.05	0	528.29
TRIPS	Existence of TRIPS agreement (1=yes) in time t	0.25	0.43	0	1
PATENT	Depreciated U.S. patent stock in Country i in Time t based on actual depreciated patent flows (in thousands)	12.86	25.90	0	132.75

Table 1-7: Probit estimation of a case in a country panel
(Four 7-year time intervals in 7 industries for 78 countries)

Dependent Variable: CASE-1: Existence of a Case filed in Time t, Industry j, Country i						
Regression #	7.1	7.2	7.3	7.4	7.5	7.6
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	No	No	No	No	No	Yes
Log(Δ gdp)	0.093 (0.53)	0.692 (3.82)***	-0.074 (-0.44)	-0.023 (-0.10)	0.059 (0.33)	-0.846 (-2.28)**
Log(corrupt)	-0.125 (-2.11)**	-0.097 (-1.78)*	-0.166 (-2.75)***	-0.117 (-1.79)*	-0.263 (-3.31)***	0.208 (1.13)
Log(Ginarte-Park)	—	—	—	0.134 (1.10)	—	—
Log(industry imports)	0.410 (12.64)***	—	0.254 (5.73)***	0.396 (11.64)***	0.414 (12.55)***	0.282 (5.93)***
Log(industry import growth)	—	0.087 (1.80)*	—	—	—	—
Log(total imports)	—	—	0.290 (4.71)***	—	—	—
TRIPS (1 if yes, 0 if no)	-0.767 (-6.61)***	-0.482 (-4.53)***	-0.837 (-7.03)***	-0.870 (-6.75)***	-0.776 (-6.65)***	-0.664 (-4.42)***
Log(patent stock)	0.097 (3.40)***	0.355 (12.22)***	0.036 (1.19)	0.064 (2.16)**	0.039 (1.12)	0.017 (0.23)
Log(patent stock) x Log(corrupt)	—	—	—	—	0.061 (2.38)**	—
# of Observations	2184	2184	2184	1876	2184	1092
Pseudo R ²	0.4270	0.2997	0.4404	0.4029	0.4301	0.3636
Log-likelihood	-472.654	-577.607	-461.534	-410.883	-470.059	-391.476

Notes: Z-Statistics in parentheses. *, **, *** represent significance levels at the 10%, 5%, and 1% levels, respectively. Missing Ginarte-Park data for 11 countries resulted in fewer observations in Regression 8.4. With country dummies, all countries without at least one case (half of the full sample) are dropped in the Probit model in Regression 8.6.

Table 1-8: Respondent country cases in a country panel (Four 7-year time intervals in 7 industries for 78 countries)

Dependent: Variable	Log(CASE-2): Log(Respondent country cases in Time t, Ind. j, Country i)				CASE-2: Respondent country cases in Time t, Ind. j, Country i		
	8.1	8.2	8.3	8.4	8.5	8.6	8.7
Regression #							
Estimation Method	OLS	OLS	OLS	OLS	Negative Binomial Regression		
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	No	No	No	Yes	No	No	Yes
Log(Δ gdp)	0.007 (0.08)	0.093 (0.88)	0.014 (0.14)	-0.055 (-0.51)	0.441 (1.78)*	1.555 (5.52)***	-0.784 (-1.97)**
Log(corrupt)	-0.065 (-1.34)	-0.225 (-4.32)***	-0.067 (-1.38)	0.192 (1.35)	0.003 (0.04)	0.035 (0.42)	0.109 (0.53)
Log(industry imports)	0.375 (18.92)***	—	0.302 (11.09)***	0.162 (6.26)***	0.628 (15.01)***	—	0.404 (7.50)***
Log(industry import growth)	—	0.019 (0.48)	—	—	—	0.147 (1.81)*	—
Log(total imports)	—	—	0.128 (3.87)***	—	—	—	—
TRIPS (1 if yes, 0 if no)	-0.528 (-6.40)***	-0.270 (-3.07)***	-0.567 (-6.85)***	-0.353 (-4.47)***	-1.271 (-8.58)***	-0.889 (-5.54)***	-0.832 (-5.45)***
Log(patent stock)	0.013 (0.87)	0.188 (15.57)***	0.011 (0.714)	0.047 (1.03)	0.186 (4.45)***	0.684 (15.94)***	0.054 (0.63)
# of Observations	2184	2184	2184	2184	2184	2184	2184
Adjusted/Pseudo R ²	0.2852	0.1674	0.2898	0.4532	0.3290	0.2279	0.4080
Root MSE/Log LH	1.635	1.764	1.629	1.430	-867.913	-998.682	-765.746

Note: T-Statistics in parentheses. *, **, *** represent significance levels at the 10%, 5%, and 1% levels, respectively.

Table 1-9: Respondent firms in a country panel (Four 7-year time intervals in 7 industries for 78 countries)

Dependent: Variable	Log(CASE-3): Log(Respondent firms in Time t, Ind. j, Country i)				CASE-3: Respondent firms in Time t, Ind. j, Country i)		
	9.1	9.2	9.3	9.4	9.5	9.6	9.7
Regression #							
Estimation Method	OLS	OLS	OLS	OLS	Negative Binomial Regression		
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	No	No	No	Yes	No	No	Yes
Log(Δ gdp)	0.028 (0.24)	0.130 (1.02)	0.036 (0.31)	-0.061 (-0.47)	0.764 (2.58)**	2.130 (6.65)***	-0.849 (-1.77)*
Log(corrupt)	-0.061 (-1.03)	-0.253 (-4.03)***	-0.063 (-1.08)	0.225 (1.33)	-0.028 (-0.27)	-0.157 (-1.34)	0.361 (1.30)
Log(industry imports)	0.452 (18.89)***	—	0.361 (10.99)***	0.190 (6.13)***	0.773 (15.82)***	—	0.448 (6.76)***
Log(industry import growth)	—	0.027 (0.54)	—	—	—	0.445 (3.72)***	—
Log(total imports)	—	—	0.159 (3.98)	—	—	—	—
TRIPS (1 if yes, 0 if no)	-0.670 (-6.74)***	-0.360 (-3.39)***	-0.719 (-7.20)***	-0.451 (-4.77)***	-1.773 (-9.02)***	-0.587 (-2.78)***	-1.460 (-6.50)***
Log(patent stock)	0.016 (0.90)	0.226 (15.56)***	0.014 (0.737)	0.055 (1.00)	0.210 (4.93)***	0.692 (17.21)***	0.090 (0.80)
# of Observations	2184	2184	2184	2184	2184	2184	2184
Adjusted/Pseudo R ²	0.2834	0.1658	0.2883	0.4578	0.2324	0.1603	0.2996
Root MSE/Log LH	1.971	2.126	1.964	1.715	-1436.06	-1571.06	-1310.44

Note: T-Statistics in parentheses. *, **, *** represent significance levels at the 10%, 5%, and 1% levels, respectively.

strong evidence that firms tend to take greater action for IPR infringement when there is a higher potential for punishment. Industries within countries that compete most directly with their U.S. counterparts tend to generate a higher number of cases, since each successful case may result in fewer competitive imports. This result is consistent with findings in the antidumping literature (Blonigen, 2000) which finds a significantly positive relationship between imports and antidumping investigations. Using the coefficients from Regressions 7.1, 8.1 and 9.1, a one standard deviation increase in U.S. industry imports (\$10.62 Billion) from a country increases the likelihood of a case occurring by 96.9 %, and results in 0.17 additional country cases and 0.95 additional respondent firms for that specific industry and country, an increase of 61% and 74% from the mean, respectively.¹⁰ These results are robust when total imports from all industries are added in Regressions 7.3, 8.3, and 9.3, implying that they are not spuriously reflecting general trading patterns.

The import growth variable is tested to determine whether firms respond to changes in the level of imports within an industry rather than the actual level of industry imports. The relatively weak coefficients suggest that this is not very likely. The likelihood and extent to which cases are filed are better explained by the level of imports within an industry. This finding is consistent with Finger (1981), which determined that the level, and not changes, in imports affects the extent of antidumping filings.

Evidence shows that corruption indicators are mostly negatively linked to case filings, which contradicts the hypothesis that that firms are better able to build a case

¹⁰ The effect of OLS coefficients is calculated using the following formula: $\log(\mu_1 + x) - \log(\mu_1) = \alpha[\log(\mu_2 + \sigma) - \log(\mu_2)]$ where μ_1 and x are the mean and change from mean of the dependent variable, respectively, and μ_2 and σ are the mean and standard deviation of the independent variable.

against countries that are more likely to infringe on intellectual property based on corruption found in the country. The negative binomial results are closer to expectations, though the coefficients are insignificant. As in most variables used in this model, the lack of industry-specific corruption indicators results in less variation between observations. Nonetheless, the results suggest that corruption levels do not influence IPR enforcement directly. For example, the corruption results may be due to U.S. firms withholding innovations from corrupt countries. The correlation between corruption and the patent stock is -0.4398.

In Regression 7.4 the Ginarte-Park index of patent protection is added in addition to the corruption indicator. There is no significant relationship between this measure of patent protection and IPR complaints. This result is consistent throughout all regressions.

The U.S. patent stock has a positive impact on case filings in all regressions, though with varying degrees of significance. The variable is highly significant when the trade effect is measured by import growth, in the Probit model without total imports, and in the negative binomial regressions without country fixed effects. These findings suggest that as the pool of patents increases, the use of U.S. knowledge increases, resulting in a greater likelihood that a patent may be violated, which therefore results in greater incidence of firm investigations. The negative binomial estimates (Regressions 8.5 and 9.5) show that a one standard deviation increase in the U.S. patent stock in a country (25,900 patents) results in 0.035 additional country cases and 0.158 additional respondent firms, an increase of 13% and 12% from the mean, respectively.¹¹

¹¹ The magnitudes of the negative binomial coefficients are calculated using the same formula as the OLS coefficients. Though not explicitly written in log form, the inherent specification of the negative binomial is $\log \lambda_{ijt} = x_{ijt} \alpha$, where λ_{ijt} is the Poisson parameter written in log form to ensure non-negativity.

To further shed light on the interactive effect of the patent stock and corruption or patent protection, interaction variables are created to test for the possibility that a large patent stock or high corruption level alone does not directly affect case filings. However, a large patent stock in countries with high corruption levels may lead IPR to be more vulnerable to infringement. An interaction variable with the corruption indicator and patent stock is included in Regression 7.5 and the coefficients reveal expected positive signs. The OLS and negative binomial results (not reported) also yield similar results.

We find evidence that since the implementation of the TRIPS Agreement, the level of cases significantly decreased. Specifically, the average number of country cases and respondent firms decreased from 0.30 to 0.20 and 1.50 to 0.64, respectively, an average decrease of 45%. These results support the intention of TRIPS to encourage stronger protection of IPR, particularly with trade-related issues. Since the inception of TRIPS, the reduction of IPR violations resulted in fewer cases filed. In addition, Probit Regression 7.1 shows that the inclusion of the TRIPS dummy reduces the likelihood of a case by 77%.

The economic variable ΔGDP (change in real GDP) is shown to be positively (though mostly insignificantly) correlated with IPR investigations without country fixed effects, with larger coefficients from the negative binomial model. This finding, though relatively weak, contradicts that of the antidumping literature (Sabry, 2000) where positive macroeconomic factors reduce investigations. However, the signs in this model change when country fixed effects are added. The inconsistent results can be partially attributed to aggregation-- because changes in GDP are averaged over a seven-year period, year to year economic fluctuations are not picked up.

Finally, industry fixed effects are included to control for time-invariant industry characteristics that may inherently result in greater or fewer investigations. The dummy coefficients indicate that Industry Category 2 (chemicals/pharmaceuticals) and Category 4 (metals/machinery) have higher number of investigations not controlled by other variables. Possible explanations include a greater intensity of competition due to the innovation-intense nature of the industries where innovations often build upon each other.

Further Sensitivity Tests

This section is devoted to testing two alternative specifications of the dependent variable in the previous model. First, we distinguish between cases that are successful and unsuccessful to the complainant, and test whether the explanatory variables explain the number of successful cases. Secondly, we address the question whether the size of complainants affects the results. The motivation for the latter test is that larger complainants tend to have larger claims, and therefore file larger and higher profile cases. We account for this by giving greater weight to cases filed by larger complainants.

The breakdown of verdicts of cases filed is shown in Table 1-10. A 'successful' case is defined as one that favors the complainant, which includes cases closed by settlement, cases closed by consent, or cases which find violation against the accused firm. A majority of successful cases (61%) are closed by settlement, generally by way of the accused firm entering into a licensing agreement with the complainant regarding the IPR in dispute. Overall, successful cases account for 75% of all cases.

Table 1-10: Breakdown of cases by verdict

Total Cases	439	100%			
Closed by Settlement	201	46%	No Violation	76	17%
In Violation	88	20%	Case Withdrawn	23	5%
Closed by Consent	39	9%	Case Suspended	12	3%

Each equation in the previous model is re-estimated using only 'successful' cases, limiting data to those that result in favor of the complainant. The results from these tests are not displayed because they are qualitatively identical to the estimation of both successful and non-successful cases combined. This suggests that a majority of cases filed are legitimate actions where the complainant has strong evidence of an IPR violation, and therefore is not simply using the enforcement mechanism as a means to file frivolous cases. Indeed, given the high overall success rate, this premise is supported.

One potential concern with the dependent variable count is the large difference in profile of cases. For example, some cases involve a small firm or individual as the complainant, while others involve large multi-national corporations. In order to allow for variation in the size of firms involved, one approach is to take a weighted value of the number of respondent cases; this is achieved by multiplying each case by a scalar corresponding to the sales value of the complainant. In this study, annual sales data are obtained from *OneSource*. Because a portion of firms did not appear in *OneSource*, other sources (firm websites and direct firm contact) were consulted. For a few remaining firms, an approximate sales estimate was generated based on number of employees (\$200,000/employee). All sales data are in constant 1990 dollars.

In separate regressions, a weighted count of the CASE dependent variable is estimated, where a larger scalar is applied to larger complainants.¹² This allows one to test the plausible assumption that the actions of larger firms carry greater effects than their smaller counterparts. Thus, a weighted dependent variable is created as follows:

¹² A scaled value of sales is used to allow larger firms to be weighted more without eliminating the importance of small firms due to vast differences in sales volumes. The scaled indicator chosen ranges from 1 to 10 according to sales volumes (in \$millions) as follows: 0 to 1, 2 to 25, 26 to 100, 101 to 250, 251 to 500, 501 to 1,000, 1,001 to 2,500, 2,501 to 5,000, 5,001 to 10,000, over 10,000.

$$W\text{-CASE-}N_{ijt} = \sum_{ijt} [(S_n \times \text{Respondents}_{ct})] \quad (1-4)$$

where $n = (1, 2, \dots, 10)$ and $N = (2, 3)$. S_n is a scalar ranging from 1 to 10 depending on the annual PPI-corrected sales of the complainant firm in Case c . Respondents_{ct} is the number of respondent countries or firms corresponding to Case c . Each weighted respondent value in Country i , Industry j , and Time t are summed to form the modified dependent variable, $W\text{-CASE-}N_{ijt}$, that is then re-estimated using Equation (1-3).

Results from the weighted CASE variables, where each country case and respondent firm is given a weight according to the size of the complainant (on a scale of 1 to 10 as described in footnote 12), are qualitatively identical to the non-weighted CASE variables, and therefore are not reported. This finding implies that the size of complainants does not matter.

Conclusion

This paper provides unique evidence on IPR enforcement. We investigate factors that influence the extent to which IPR are violated internationally, as well as factors that affect the extent to which firms file complaints against foreign entities for alleged IPR infringement utilizing an enforcement mechanism available with the USITC. Our findings suggest that the latter factors are more important in explaining the number of investigations filed.

Recent studies have found IPR infringements in industrialized countries, though relatively lower in probability compared to LDCs, cause significant aggregate damage.¹³ In this study, we find this to be consistent with U.S. firm actions for IPR enforcement.

¹³ The IIPA (1998) offers annual estimates of losses due to IPR infringement. It finds that though developing countries have the highest piracy rate, industrialized countries cause the most damages in value. This finding is consistent with Marron and Steel's (2000) finding that many industrialized countries have a substantial number of violations despite an established system of IPR protection.

The results show that firms tend to pursue actions where available sanctions are most valuable; therefore, the ability to impose trade sanctions is a valuable tool to use against firms in countries that manufacture and export large values of potentially infringing goods. This provides evidence that firms take advantage of the ability to punish and receive compensation for alleged IPR violations. Consequently, actions aimed toward firms in lesser-developed countries, which have been the focus of IPR in recent decades, are not as prevalent as those against firms in industrialized countries. In this study, we find that firms file cases against foreign firms that compete most directly within its specific industry by way of industry-specific imports.

In addition to trade, we find that industries in countries with greater access to technologies through foreign patenting tend to initiate more complaints of IPR violation, suggesting a trade-off between greater dissemination of technologies and the higher incidence of IPR violations. We find that corruption levels do not directly influence the extent of enforcement. Finally, there is evidence that the TRIPS agreement, the most comprehensive IPR treaty to date, has brought about a reduction in IPR violations.

One of the limitations of the paper is analyzing cases that involve U.S. complainants, where sanctioning power is limited to trade sanctions rather than monetary compensation. However, there currently does not exist a central court that possesses the authority to enforce IPR for all countries. Because every country has its own interpretation of what constitutes "infringement," empirical studies on cross-border court litigation will need to account for differences in IPR law and its enforcement between countries. Given these obstacles, this paper offers insights to cross-border IPR enforcement without concern of jurisdictional issues and differences in laws.

CHAPTER 2

MARKET COMPETITION IN THE UNITED KINGDOM: THE EFFECT ON INTERNATIONAL INTELLECTUAL PROPERTY RIGHTS LITIGATION

Introduction

In recent decades, the competition for market share in knowledge-intensive goods has rapidly intensified throughout the global economy. These goods rely on innovative characteristics that are protected via intellectual property rights (IPR). The protection of IPR, particularly those rights that protect innovations that are widely used and therefore prone to imitation, entails large costs. Many firms and individuals seek prosecution of alleged violations by engaging in court litigation to redeem monetary damages caused by alleged violators. This form of enforcement is common between entities within a single country where each party is generally subject to the same laws and courts. However, in an increasing global economy, alleged IPR violations frequently occur outside of the innovator's country or by firms based in a foreign country. In such multi-country cases, the ability to enforce IPR becomes more difficult.

This paper analyzes the decision to pursue litigation involving more than one country in a simplified framework. A model focusing on a single market, the United Kingdom (U.K.), is introduced to characterize the actions of both U.K.-based firms and firms that are affiliates or subsidiaries of foreign-based parent firms. Each firm, regardless of origin, has a common interest of gaining market share in the U.K. within its respective industry. However, allegations of IPR violations frequently occur as competition rises; many of these allegations involve firms from more than one country.

Utilizing a unique dataset of litigation cases conducted by the courts of the United Kingdom and the British Commonwealth,¹ an empirical model is introduced to examine patterns and the determinants of IPR court litigation between firms from different countries within the jurisdiction of the U.K. courts.

The literature on cross-border IPR litigation mostly consists of policy papers and legal studies. Pooley (1999) discusses strategies that patent owners should consider prior to engaging in cross-border litigation. These factors include cost-benefit analyses, logistics and procedures, and political risks. Arnold (1999) examines jurisdictional issues on cross-border litigation, using examples from actual court cases. Finally, Dutson (1998) studies the difficulties of enforcing IPR across borders in the Internet age, where jurisdiction is often undefined due to the worldwide presence of the Internet. These studies and others all allude to common concerns regarding the adequate enforcement of IPR between firms in different countries: the interpretation of jurisdictional boundaries, and asymmetries in IPR law and their enforcement within individual countries.

Nearly all of the empirical research on IPR enforcement focuses on domestic disputes and unilateral cross-border enforcement. Lanjouw and Schankermann (2001) find the propensity to pursue court litigation rises when the value of stakes involved is higher. Using a set of litigated U.S. patents, they find patent litigation more likely when 1) the number of claims and/or the number of forward citations (patent references made by future applications) made by the patent is greater, 2) industries are "crowded" (those with many competing firms), and 3) the patent is in a new technology area (one with fewer backward citations). Although their analysis is limited to the litigation of U.S.

¹ We choose to analyze cases from the UK and British Commonwealth because a large proportion of these cases involves more than one country, allowing for more feasible manual data collection.

patents, Lanjouw and Schankermann do distinguish between domestic and foreign ownership. They find that foreign patents are much less likely to be enforced than domestic patents, presumably due to large fixed costs of litigating abroad. This suggests that IPR infringements are perhaps more rampant when firms from more than one country are involved.

This paper utilizes a novel approach to explain IPR litigation across national borders within a single legal framework. Four key regions are studied: United Kingdom, United States/Canada, Europe (except U.K.), and Asia/Pacific. This study examines a large selection of IPR cases conducted by the U.K. and British Commonwealth courts between 1981 and 2000. The motivation behind this framework is that firms from different countries have sufficient interests within the U.K.; as a result, they utilize the U.K. courts to resolve disputes. No previous research has studied the interaction of firms from multiple countries within a single market structure. In many cases, the issue at stake involves the loss of competitive market share resulting from alleged IPR violations. This study focuses on market competition within the U.K. where key players are both U.K.-based firms and affiliates/subsidiaries of foreign-based firms. This paper seeks to ascertain the key factors that motivate IP rights owners to pursue costly court action within the U.K. legal system to protect their innovations from infringement.

IPR Protection and IPR Enforcement

Recent research has studied why firms choose to protect innovations abroad. Eaton and Kortum (1996) analyze the decision to apply for patent protection abroad based on industry-level and country-level economic factors, such as perceived patent protection in a country. But the decision to protect innovations through the application of

foreign IPR is just one decision. The other is the decision to enforce the IP right should it become infringed upon. Lanjouw and Lerner (1998) develop a simple theoretical model on the decision to litigate a patent based on the benefits and costs of litigation, along with the probability of success. In this paper, the decision to litigate a patent is modified to account for multi-country factors influencing the process; this facilitates the development of a feasible empirical model. The decision model facing each firm is presented first.

Following a decision to initiate an enforcement action,² conditions facing each party will influence a plaintiff's willingness to enter into a settlement or to pursue the full litigation process. This paper attempts to explain cases that proceed through the full litigation process, which results in the estimation of the following joint probability:

$$\begin{aligned} & [\text{Pr(IPR Violation)} \times \text{Pr(Full Litigation | IPR Violation)}] + \\ & [\text{Pr(no IPR Violation)} \times \text{Pr(Full Litigation | no IPR Violation)}] \end{aligned} \quad (2-1)$$

where both guilty and innocent parties can be taken into trial.

Consider the simple game tree in Figure 2-1:

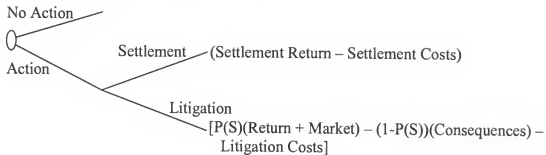


Figure 2-1. Game tree diagram of an IPR enforcement decision

² This paper attempts to explain whether fully litigated IPR court cases involving parties from different countries occur. Previous studies have analyzed why firms choose to avoid litigation based on negative publicity. Bhagat, Brickley, and Coles (1994) and Lerner (1995) find that publicly traded firms lose an average value of 3.1% and 2.0%, respectively, following an announcement of an IPR enforcement action. Both findings are significant at the 1% level. This result is interesting since these firms are *plaintiffs*; however, shareholders tend to respond negatively to uncertainty.

In the payoff for the litigation decision, there are three key components:

- $P(S)$, the probability of a successful case.
- Return + Market, the monetary value of the judgment to the plaintiff plus the value of market share regained.
- Consequences and Litigation Costs; consequences stem from the likelihood of counteractions taken from a successful defendant, and litigation costs apply regardless of litigation results.

In order to develop a feasible empirical model, several assumptions are introduced. First, the probability of success is assumed to be exogenous, although in truth it is likely based on the type of IP right being litigated along with characteristics of the firms, lawyers, and courts involved. Secondly, the costs and consequences of litigation are assumed to rise with the stakes involved, but at a constant rate and therefore not directly influenced by external factors. Finally, the decision to pursue settlement options (not studied in this paper) is assumed to be contingent on the level of uncertainty of the probability of success by one or both parties, due to information asymmetries. If both parties have symmetric information, then settlement options are attractive when both parties realize a likely outcome of a potential trial. If the outcome is uncertain, then a full trial may be necessary. In cases where parties have different information, settlements are attractive when one party has a low assessment of its likelihood of winning a full trial. Cases that are carried out in court (and estimated in this model) are those where both parties have a neutral or confident assessment of their own probability of success, which makes pursuing a complete trial worthwhile. As a result, the data show that the average success rate of cases taken to trial is approximately 50%, which implies that only cases that are uncertain, and therefore not attractive to a settlement, are tried in court.

Given these assumptions, what remains of the decision to pursue litigation are the potential returns or stakes involved with each case; furthermore, it is possible to capture these tangible factors based on available empirical data. Specifically, we analyze factors that affect the expected gains from a successful case (holding the probability of a successful case constant); these expected gains are influenced by market characteristics within an industry between the regions involved. A number of these factors, such as market crowding, have been introduced in previous studies. However, this model also introduces variables that specifically address cross-border enforcement, for example, the extent of foreign penetration via trade, foreign direct investment, and the introduction of affiliates or subsidiaries of foreign-based firms.

Empirical Outline

This paper utilizes data on court litigation involving parties from more than one country within a single legal framework and jurisdiction of the U.K. court system. The purpose of this model is to characterize the interaction of a plaintiff and a defendant belonging to one of four regions: U.K., U.S./Canada, Europe (except U.K.), and Asia/Pacific (see Table 2-1 for list of selected countries within each region). Firms or individuals from each region can serve as plaintiffs; however, due to personal-matter jurisdictional rules, it is necessary that a defendant must either have physical presence in the U.K. or have an affiliate or subsidiary within its boundaries. In all cases, the attributes tied to each case correspond to the region of the ultimate parent of the litigants.

This paper analyzes sets of two-region interactions corresponding to the home location of the plaintiff and defendant parties. Because there are four regions, the maximum number of 2-region interactions is twelve (i.e., US vs. U.K., Europe vs. U.K.,

Asia vs. U.K., and so forth with each region serving both roles), with all relevant data mapped accordingly to each interaction. In this paper, we do not consider all twelve interactions simultaneously because the inclusion of U.K.-based firms may bias the results as all cases are tried under its own courts. This is particularly true for U.K. firms serving as defendants because they naturally fall under its own jurisdiction, whereas non-U.K. firms do not. Furthermore, variables measuring foreign presence in the U.K. do not apply in cases with U.K. defendants. As a result, this paper uses two sets of interactions: one with nine 2-region interactions (omitting interactions with a U.K. defendant), and one with six 2-region interactions (focusing strictly on non-U.K. regions).

Each 2-region interaction in these models is further classified into nine distinct industries (shown in Table 2-5) using a broad 2-digit SIC categorization. Due to limitations in data, further disaggregation of industry categories may cause potential problems. The model has two 10-year periods (1981 to 1990 and 1991 to 2000). The total number of observations with nine 2-region interactions is 162; with six 2-region interactions, there are 108 observations.

Table 2-1: Four regions and the corresponding countries

Region	Countries
U.K.	United Kingdom
USA	United States, Canada
Europe	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland
Asia/Pacific	Australia, China, Hong Kong (China), India, Japan, Korea, New Zealand, Philippines, Singapore, Taiwan, Thailand

This model focuses on the regional determinants of cross-border litigation. This is justified as long as countries within a region are relatively similar in their economy and firm structure. For example, if a U.S. firm takes enforcement actions against a German-

based firm, these actions are likely taken because of the firm's location, and not the result of a direct action against Germany. In other words, the decision to litigate against the firm would likely remain the same if it were a French-based firm. This probability is due to a regional effect: countries within a region have similar laws and market structure. But this is not the case between regions themselves— i.e. Europe and Asia. Focusing on regional variables minimizes the estimation of stochastic firm characteristics.

There are a number of implications of analyzing cross-border cases within a single framework. Utilizing a single legal framework under the U.K. court system facilitates the legal interpretations of multi-country cases; however, it also defines the relevant market as the U.K. market. The focus of the enforcement decision is influenced by the competition for market share in the U.K. (but may also theoretically extend to the plaintiff's home market). This premise is important when defining the source of an IPR violation. A violation may theoretically occur outside of the U.K. by a foreign-based firm; however, if there exists a subsidiary within the U.K., it may be subject to court litigation. A second scenario exists in cases where a plaintiff is a non-U.K. firm. Although the existence of a U.K. subsidiary is not a prerequisite for court litigation, a plaintiff firm must have a legal basis for initiating a case (i.e. a U.K. patent owned by the plaintiff). In all cases, the presence of non-U.K. firms in cross-border cases is likely influenced by conditions within the U.K. market facing the parties in trial.

Data for the dependent variable derive from the actual court litigation cases. Explanatory variables measure: 1) industry crowding within the U.K. by industry and time period, 2) industry-specific foreign direct investment into the U.K. by each region over each time period, 3) the number of foreign affiliates of transnational corporations by

region within the U.K. in each time period, 4) trade flows into the U.K. measured by region and industry over time, 5) the number of U.K. patent applications by region over time, 6) indices of the existence of legal mechanisms and the effectiveness of IPR enforcement in the defendant region, 7) time dummies accounting for the existence of recent international treaties (i.e., Lugano Convention), and 8) regional and industry dummies. The discussion of each variable follows.

The central hypothesis of this model is that cross-border IPR litigation is influenced by competition. First, competition is measured by overall market crowdedness within an industry in the U.K. A larger number of firms within a single market increases competitive interactions, thereby increasing the potential pool of plaintiffs. Furthermore, as the number of firms increases, the intensity of competitive actions rises, including accusations of IPR violations. Thus, overall market crowdedness is expected to increase litigation.

Secondly, competition involves the value of stakes stemming from the U.K. market against foreign competitors. Specific measures include the extent of foreign penetration into the U.K., which occurs through three primary channels: import trade,³ foreign direct investment, and the existence of affiliates of foreign-based firms. Similar to overall market crowdedness, each of these channels of foreign penetration raises the potential value of engaging in court litigation, thereby increasing its occurrence.

It is important to note that foreign penetration into the U.K. not only affects U.K.-based firms but also existing foreign-based firms. As the level of foreign penetration

³ The relationship between intellectual property and international trade is well documented by Maskus and Penubarti (1995), who find that countries with greater IPR protection import more IPR protected goods, suggesting that innovating firms are more willing to export goods to countries less likely to violate IPR.

into the U.K. from a defendant region increases, existing firms (potential plaintiffs from all regions) within an industry face greater competition. We account for this by assuming that each foreign penetration variable affects the likelihood of court litigation depending on how it affects the plaintiff's current market share in the U.K. market. For example, foreign direct investment by Asia into the U.K. is expected to increase the likelihood of court actions taken against Asia; however, the region most likely to initiate a case is the one which has the largest existing market share for the industry in the U.K. Conversely, a region that has very little presence within the industry in the U.K. is less likely to be affected by the foreign penetration, and thus is less likely to file a case. For this reason, each foreign penetration variable is multiplied by the corresponding market share of each potential plaintiff region. Market share for each U.K. industry n [$n \in (1,9)$] in time t [$t \in (1,2)$] is defined as the total number of firms by each region p [$p \in (1,4)$] divided by the total number of firms from all regions ($\# \text{ plaintiff firms}_{\text{pnt}} / \# \text{ total firms}_{\text{nt}}$).

Example: for each of the regional interactions in the following select sample, the corresponding measure of foreign direct investment would be as follows:

Plaintiff = U.K., Defendant = Asia $\Rightarrow$ (FDI – Asia into U.K.) $\times$ (U.K. market share),

Plaintiff = Europe, Defendant = Asia $\Rightarrow$ (FDI – Asia into U.K.) $\times$ (Europe market share),

Plaintiff = U.S., Defendant = Asia $\Rightarrow$ (FDI – Asia into U.K.) $\times$ (U.S. market share),

where market share is measured by industry n in time t within the U.K.

The modification of each foreign penetration variable in essence creates *effective* foreign penetration variables, defined as the effect of the foreign penetration variable on existing firms (potential plaintiffs) in the U.K. As each *effective* foreign penetration variable rises for a particular plaintiff region, court litigation is expected to increase.

A measure of technology access is included in the model to capture the level of technology flows from the plaintiff region into the U.K., which is expected to have a positive correlation with case litigation. From a legal standpoint, it is important to note that legal actions can only be taken against a defendant firm within the U.K. when a U.K. law is violated (i.e. patent infringement). Therefore, plaintiff firms must file for IPR protection within the U.K. by obtaining a patent prior to litigation. In this model, technology access is measured by the depreciated patent stock by industry from the plaintiff region into the U.K. We utilize patents exclusively, even though this analysis concerns all types of intellectual property. However, the availability of data on patents is most consistent; furthermore, the level of technology access represented by patents closely parallels the use of other IPR.

The extent by which defendant countries protect IPR domestically is another important factor. A potential defendant firm in a country with relatively weak protection may tend to engage in greater profit-seeking activities, including penetrating the U.K. market with imitated goods. If domestic enforcement of IPR violations in defendant countries is strong, it is less likely that cross-border violations will occur, thereby reducing the extent of alleged violations within the U.K. A measure of IPR protection across 110 countries is provided by Ginarte and Park (1997) and is based on memberships in international treaties as well as the coverage, restrictions, and duration of IPR within a country. Moreover, Ginarte and Park incorporate elements of domestic IPR enforcement in their index. It is expected that a higher Ginarte and Park rating be associated with a smaller number of allegations against a defendant country and hence its region.

Over the past two decades, various treaties were established to strengthen IPR law across countries, as well as to facilitate the litigation process between firms in different jurisdictions. The Trade-related Intellectual Property Rights (TRIPS) Agreement and the Brussels and Lugano Conventions are recent examples that aim toward these goals. This model includes a time dummy to account for the existence of these conventions. It is expected that litigation will fall as IPR is strengthened as a result of these conventions.

Data

The collection of multilateral data is a key component of this analysis, as most data are not readily accessible. In this model, actual IPR court litigation case data are collected by manual analysis of each individual case as reported by two prominent law reporting sources: *Fleet Street Reports of Industrial Property Cases from the Commonwealth and Europe* and *Reports of Patent, Design, and Trademark Cases*.⁴ These sources focus on cases that are tried by U.K. courts, a majority by the Chancery Division of the High Court, under which there exists a specialized Patent Court. A majority of reported cases involve parties from multiple countries; this model focuses exclusively on these cases. The mapping of case data into regional and industrial categories is undertaken by comparing case data with information contained in *OneSource* and other Internet sources. Industrial classifications are taken from the original SIC system (since most data came prior to the current NAICS system).

Summary information on the selection of case data is shown in Tables 2-2 to 2-7. Table 2-2 reports the total number of cases by each reporting source, while Table 2-3

⁴ Each source has been in existence for over 50 years, and the procedure by which cases are reported by each respective source is established such that there are no overlaps in reported cases.

shows the annual case count. Although there are apparent year-to-year differences in the number of cases, there appears to be no long-term trend. Table 2-4 breaks down cases according to the type of IPR in dispute. The *Fleet Street Reports of Industrial Property Cases from the Commonwealth and Europe* contains a more balanced selection of cases, while *Reports of Patent, Design, and Trademark Cases* picks up a larger share of patent cases. The overall sample proportion of types from the two sources closely parallels the approximate proportion of types among all cases. Table 2-5 shows the industrial classification of cases. Table 2-6 breaks down cases according to the presiding court; these numbers are correlated to Table 2-4 in terms of the type of IPR in dispute. Finally,

Table 2-2: Total number of cases reported

Total Cases Reported: 768
By <i>Fleet Street Reports of Industrial Property Cases from The Commonwealth and Europe</i> (1981-2000): 523
By <i>Reports of Patent, Design, and Trademark Cases</i> : (1981-2000): 245

Table 2-3: Year of court litigation

Year	FSR	RPC	Year	FSR	RPC	Year	FSR	RPC
2000	27	9	1993	24	12	1986	22	15
1999	24	9	1992	26	12	1985	27	7
1998	35	9	1991	29	14	1984	30	11
1997	34	9	1990	19	16	1983	27	11
1996	26	8	1989	19	17	1982	24	16
1995	25	17	1988	26	15	1981	35	9
1994	25	15	1987	19	14	Total	523	245

Table 2-4: Types of cases

Type of Case	FSR	RPC	Total	% of Total
Patent Infringement	148	125	273	36%
Trademark Infringement	55	29	84	11%
Passing Off	121	34	155	20%
Copyright Infringement	179	45	224	29%
Other	20	12	32	4%
Total	523	245	768	100%

Table 2-5: Type of product involved

SIC Codes	Description	FSR	RPC
2800 to 2899	Pharmaceuticals and Chemicals	75	50
3000 to 3399	Primary Materials	50	15
3400 to 3599*	Machines and Tools	57	43
3600 to 3699*	Electronic Goods	32	16
Computers*	Computers and Software	34	16
3800 to 3899	Medical Supplies & Equipment	33	15
Manufactures**	Remaining Manufactures	107	58
>5000*	Services	134	31
<2000, 4000 to 4999	Other Industries	1	1
Total	All Industries	523	245

*SIC Codes 3571 to 3573, 3661, 3674, and 7372 are classified into computers, and thus are not part of the Machines, Electronics, or Services categories.

**This category includes all manufactures not classified elsewhere, including 2000 to 2799, 2900 to 2999, 3700 to 3799, and 3900 to 3999.

Table 2-6: Court of litigation

Court	FSR	RPC	Total	% Total
U.K. High Court Chancery Division	248	60	308	40%
U.K. Court of Appeals	80	63	143	19%
U.K. Patent Court	93	74	167	22%
Other U.K. Courts*	24	20	44	6%
Commonwealth Courts**	78	28	106	14%
Total	523	245	768	100%

*These include the Outer House, Inner House, Patent County Court, and the High Court Queens Branch Division

**These include courts in the following countries: Australia, Bahamas, Bermuda, Hong Kong, India, Ireland, New Zealand, and South Africa

Table 2-7 shows the aggregate number of cases that are represented by individual countries in both the role of plaintiff and defendant. Note that countries represented may be parent firms of subsidiaries in trial within the U.K. court system; if the listed country is a defendant, this condition is a prerequisite to satisfy jurisdictional rules. All countries listed are the location of headquarters of the ultimate parent of litigants in trial.

Table 2-7: Nationality of plaintiffs and defendants (by ultimate parent firm)

Plaintiff	FSR	RPC	Defendant	FSR	RPC
U.K.	274	110	U.K.	337	150
USA	120	69	USA	56	23
Germany	18	9	Germany	11	8
France	19	14	France	4	3
Netherlands	8	7	Netherlands	10	5
N.Zeal/Austr	16	6	N.Zeal/Austr	19	18
Japan	10	1	Japan	6	2
Hong Kong	3	2	Hong Kong	15	3
Sweden	9	7	Sweden	2	2
Other	46	20	Other	63	31
Total	523	245	Total	523	245

Note: Hong Kong is treated as a colony, and not as part of China, as much of the data is taken prior to the 1997 Hong Kong transfer.

Trade data are taken from recent editions of *Eurostat* (European Commission).

These volumes contain detailed import and export values at the industry level between the U.K. and US, Europe, and Asia. For the few cases of missing or incomplete data, data from the *International Trade Statistics Yearbook* (United Nations) are used. All data are corrected to reflect real U.S. dollars using a deflator (1990=1).

Detailed industry and country data on foreign direct investment (FDI) as well as U.K. affiliates and subsidiaries of transnational corporations are available from the *World Investment Directory* (United Nations). Data for FDI are available for 1980, 1990, and 2000 for each country and industry group, and in terms of flows and stocks. This model measures the average aggregate value of foreign direct investment stock by each region into the corresponding U.K. industry group over each time period. The stock of FDI (in constant 1990 U.S. dollars) is measured by the net book value (depreciation is taken into account) of all fixed assets plus working capital over each time period (the methodology for the construction of this variable is provided in the *World Investment Directory*).

Foreign affiliates are measured by the average number of total affiliates or subsidiaries of foreign parent firms within an industry in the U.K. over each time period.

Annual U.K. patent application flows are available by the World Intellectual Property Organization's *Industrial Property Statistics* and by broad industry categories from the *U.K. Patent Office Annual Reports*. Using flow data, patent stocks are constructed utilizing a 15% depreciation rate similar rates used by previous authors (see Appendix B for a reference on the methodology on constructing patent stocks from patent flow data). Measuring depreciated patent stocks allows the model to capture a level of current innovation within the U.K.

Empirical Model

This model estimates the propensity and the extent of cross-border IPR litigation. The dependent variable CASE-N ($N=1,2$) is defined as the existence of a case and the total number of complete cases, respectively, between a plaintiff in Region p [$p=1,2,3,4$] and a defendant in Region d ($d=1,2,3,4$), where $p \neq d^5$, and all subsequent appeals and counteractions are classified within the same case to avoid a selection bias. CASE-N is further categorized into Industry Classification n ($n \in 1,9$) and Time t ($t=1,2$). Utilizing Probit and Negative Binomial Models (to estimate the likelihood and extent of cases, respectively), and taking the natural log of each variable, the equation to be estimated is:

$$\begin{aligned} (\text{CASE-}N_{\text{pdnt}}) = & \alpha_0 + \alpha_{\text{pd}} + \alpha_n + \alpha_t + \alpha_1 \ln(\text{MARKET}_{\text{nt}}) + \alpha_2 \ln(\text{IMPORTS}_{\text{dnt}}) + \\ & \alpha_3 \ln(\text{FDI}_{\text{dnt}}) + \alpha_4 \ln(\text{FOR-SUB}_{\text{dnt}}) + \alpha_5 \ln(\text{PATENTS}_{\text{pt}}) + \alpha_6 \ln(\text{G-PARK}_{\text{dt}}) + \varepsilon_{\text{pdnt}} \quad (2-2) \end{aligned}$$

where $N=1,2$. CASE-1_{pdnt} is a binary variable (1=yes) for the Probit model and CASE-2_{pdnt}

⁵ As a result, this model rules out litigation between firms within the same region, even if they represent different countries (i.e. France vs. Germany).

is a count variable indicating the total number of cases and is used in the Negative Binomial model. $MARKET_{nt}$ is the total number of firms in the U.K. within Industry n during Time t . Variables representing foreign penetration into the U.K. are $IMPORTS_{dnt}$, FDI_{dnt} , and $FOR-SUB_{dnt}$, which are the real value of imports, the real value of foreign direct investment stock, and the number of U.K. affiliates of transnational corporations, respectively, from defendant Region d into the U.K. in Industry n in Time t . Each variable is multiplied by the existing U.K. market share of each potential plaintiff Region p . $PATENTS_{pt}$ is the depreciated U.K. patent stock owned by plaintiff Region p in Time t . $G-PARK_{dt}$ is the Ginarte and Park (1997) index of patent protection and domestic IPR enforcement within defendant Region d . A time dummy, α_t , distinguishes between the two 10-year periods, and ϵ_{pdnt} is a random error term that accounts for uncontrolled variables. Finally, regional-interaction and industry fixed effects, represented by α_{pd} and α_n , respectively, are included in latter regressions to account for remaining time-invariant characteristics not captured by the independent variables. For example, inherent industry features may allow for more effective litigation, or certain jurisdictional rules may allow certain cross-border actions to take place with greater efficiency. These possibilities are not captured by the control variables and hence may be controlled via fixed effects.

Results

Probit estimation results are shown in Table 2-9 (Regressions 9.1 to 9.5) and Table 2-11 (Regressions 11.1 to 11.5). Negative Binomial results are shown in Table 2-10 (Regressions 10.1 to 10.5) and Table 2-12 (Regressions 12.1 to 12.5). Summary statistics are shown in Table 2-8. The specifications in all tables are identical; Tables 2-9 and 2-10 utilize nine 2-region interactions (omitting cases with a U.K. defendant) and

Table 2-8: Variable definitions and summary statistics

Interaction Panel (9,6 regional interactions, 9 industries, 2 time periods)

Upper numbers correspond to Tables 2-9 and 2-10 with 162 observations

Lower numbers correspond to Tables 2-11 and 2-12 with 108 observations

Single numbers correspond to all Tables

Variable	Description	Mean	StDev	Min	Max
CASE-1	Binomial variable representing the existence of a case (1 = yes) within Interaction pd, Industry n in Time t	0.51 0.40	0.50 0.49	0.00 0.00	1.00 1.00
CASE-2	Actual number of cases within Interaction pd, Industry n in Time t	2.43 1.94	1.86 1.47	0.00 0.00	7.00 6.00
MARKET	Measure of market crowdedness (total number of firms by all countries) within Industry n in the U.K. in Time t (thousands of firms)	15.07	12.64	2.47	54.03
IMPORTS	Value of imports from defendant region d into the U.K. in Industry n in Time t (in billions of constant 1990 \$US)	34.06	51.65	0.60	295.68
PATENTS	Depreciated patent stock by plaintiff Region p into the U.K. in Time t based on actual depreciated patent flows (in tens of thousands)	4.57 5.68	2.49 2.30	1.50 2.34	9.58 9.58
FDI	Foreign direct investment stock from defendant Region d into U.K. in Industry n in Time t (in billions of constant 1990 \$US)	2.32	4.40	0.00	23.48
FOR-SUB	Number of foreign affiliates of defendant Region d transnational corporations (TNEs) into the U.K. (in thousands)	1.22	0.76	0.19	2.14
G-PARK	Index of Patent Protection in defendant country by Ginarte and Park (0 = least protection to 5 = most protection)	4.03	0.26	3.71	4.52
TIME	Time constant (1=1991 to 2000)	0.50	0.50	0.00	1.00

Table 2-9: Probit estimation of a case in a regional panel
(Two 10-year time intervals in 9 industries for 9 regional interactions)

Dependent Variable: CASE-1: Existence of a case filed in Time t, Ind. n, Region pd					
Regression #	9.1	9.2	9.3	9.4	9.5
Industry Dummies	No	No	No	No	Yes
Region-Int Dummies	No	No	No	Yes	Yes
Log(MARKET)	0.207 (1.27)	0.246 (1.85)*	0.244 (1.66)*	0.224 (1.75)*	-0.017 (-0.04)
Log(IMPORTS)	0.234 (0.81)	0.192 (1.56)*	0.228 (1.77)*	0.201 (1.06)	0.159 (0.90)
Log(FDI)	0.246 (1.50)^	0.262 (1.34)	—	0.914 (1.46)^	0.283 (1.18)
Log(FOR-SUB)	0.974 (1.40)	—	0.937 (1.15)	—	—
Log(PATENTS)	0.082 (0.40)	0.088 (0.43)	0.088 (0.43)	-0.355 (-0.13)	-1.819 (-0.93)
Log(G-PARK)	1.035 (0.64)	1.812 (0.97)	2.231 (1.17)	1.302 (0.55)	4.475 (1.35)
Time Constant	-0.466 (-1.89)*	-0.522 (-2.03)**	-0.502 (-1.98)**	0.629 (0.61)	4.588 (1.90)*
# of Observations	162	162	162	162	162
Pseudo R ²	0.2099	0.2092	0.2088	0.5115	0.5727
Log-likelihood	-99.94	-100.02	-100.07	-77.30	-51.90

Notes: Z-Statistics in parentheses. ^, *, **, *** represent significance levels at the 15%, 10%, 5%, and 1% levels, respectively.

Table 2-10: Negative binomial estimation of total cases in a regional interaction panel
(Two 10-year time intervals in 9 industries for 9 regional interactions)

Dependent Variable: CASE-2: Cases in Time t, Industry n, Region pd					
Regression #	10.1	10.2	10.3	10.4	10.5
Industry Dummies	No	No	No	No	Yes
Region-Int Dummies	No	No	No	Yes	Yes
Log(MARKET)	0.093 (0.52)	0.167 (1.18)	0.136 (0.87)	0.228 (1.57)^	0.050 (0.14)
Log(IMPORTS)	0.269 (1.46)^	0.379 (1.65)*	0.255 (1.61)^	0.124 (1.28)	0.065 (0.54)
Log(FDI)	0.550 (1.68)*	0.974 (1.82)*	—	0.479 (1.55)^	0.081 (0.54)
Log(FOR-SUB)	0.248 (0.96)	—	0.086 (0.48)	—	—
Log(PATENTS)	0.071 (0.32)	0.084 (0.38)	0.082 (0.37)	-1.230 (-0.85)	-1.107 (-0.78)
Log(G-PARK)	2.367 (1.09)	1.848 (0.91)	2.529 (1.18)	0.438 (0.09)	-0.491 (-0.10)
Time Constant	-0.453 (-1.59)^	-0.422 (-1.51)^	-0.422 (-1.52)^	1.493 (1.58)^	1.606 (1.69)*
# of Observations	162	162	162	162	162
Adjusted/Pseudo R ²	0.1487	0.1471	0.1477	0.2313	0.3078
Root MSE/Log LH	-126.09	-126.30	-126.21	-115.14	-105.00

Notes: Z-Statistics in parentheses. ^, *, **, *** represent significance levels at the 15%, 10%, 5%, and 1% levels, respectively.

Table 2-11: Probit estimation of a case in a regional panel
(Two 10-year time intervals in 9 industries for 6 regional interactions)

Dependent Variable: CASE-1: Existence of a case filed in Time t, Ind. n, Region p_d					
Regression #	11.1	11.2	11.3	11.4	11.5
Industry Dummies	No	No	No	No	Yes
Region-Int Dummies	No	No	No	Yes	Yes
Log(MARKET)	0.194 (0.87)	0.346 (2.01)**	0.340 (1.76)*	0.477 (2.50)**	-0.519 (-0.66)
Log(IMPORTS)	0.277 (1.51)^	0.248 (1.47)^	0.254 (1.99)**	0.259 (1.45)^	0.274 (1.57)^
Log(FDI)	0.294 (1.72)*	0.296 (1.85)*	—	0.216 (1.12)	0.313 (1.47)^
Log(FOR-SUB)	0.278 (1.05)	—	0.258 (1.29)	—	—
Log(PATENTS)	1.561 (3.54)***	1.503 (3.47)***	1.527 (3.52)***	-5.197 (-1.74)*	-7.768 (-1.71)*
Log(G-PARK)	1.842 (0.70)	1.274 (0.50)	2.537 (1.00)	12.066 (1.23)	12.630 (0.99)
Time Constant	-1.560 (-3.67)***	-1.533 (-3.62)***	-1.431 (-3.48)***	3.197 (1.56)^	5.389 (1.82)*
# of Observations	108	108	108	108	108
Pseudo R ²	0.2796	0.2718	0.2674	0.5184	0.5732
Log-likelihood	-59.56	-60.13	-60.45	-49.48	-34.78

Notes: Z-Statistics in parentheses. ^, *, **, *** represent significance levels at the 15%, 10%, 5%, and 1% levels, respectively.

Table 2-12: Negative binomial estimation of total cases in a regional interaction panel
(Two 10-year time intervals in 9 industries for 6 regional interactions)

Dependent Variable: CASE-2: Cases in Time t, Industry n, Region pd					
Regression #	12.1	12.2	12.3	12.4	12.5
Industry Dummies	No	No	No	No	Yes
Region-Int Dummies	No	No	No	Yes	Yes
Log(MARKET)	0.112 (0.43)	0.268 (1.38)	0.256 (1.17)	0.318 (1.62)*	-0.024 (-0.04)
Log(IMPORTS)	0.223 (1.04)	0.274 (1.57)^	0.277 (1.87)*	0.254 (1.39)	0.095 (0.37)
Log(FDI)	0.363 (2.01)**	0.267 (1.56)^	—	0.165 (1.11)	-0.274 (-1.67)
Log(FOR-SUB)	0.184 (0.89)	—	0.072 (0.31)	—	—
Log(PATENTS)	1.287 (2.42)**	1.256 (2.37)**	1.262 (2.40)**	-4.520 (-1.68)*	-5.011 (-1.74)*
Log(G-PARK)	2.579 (0.77)	1.867 (0.58)	2.952 (0.91)	6.533 (1.20)	4.281 (0.94)
Time Constant	-1.286 (-2.81)***	-1.238 (-2.76)***	-1.142 (-2.66)***	3.822 (1.57)^	4.821 (1.84)*
# of Observations	108	108	108	108	108
Adjusted/Pseudo R ²	0.1906	0.1853	0.1840	0.2737	0.3646
Root MSE/Log LH	-72.59	-73.02	-73.12	-65.96	-58.70

Notes: Z-Statistics in parentheses. ^, *, **, *** represent significance levels at the 15%, 10%, 5%, and 1% levels, respectively.

Tables 2-11 and 2-12 utilize six 2-region interactions (omitting all cases with a U.K. litigant). With 9 industry categories and 2 time periods, the corresponding number of observations is 162 and 108, respectively.

Regressions 9.1, 10.1, 11.1, and 12.1 are baseline regressions that include all variables presented in Equation (2-2). Regressions 9.2, 10.2, 11.2, and 12.2 and Regressions 9.3, 10.3, 11.3, and 12.3 separate the foreign penetration variables of foreign direct investment and the number of foreign subsidiaries to account for possible correlation between the two variables. Regressions 9.4, 10.4, 11.4, and 12.4 are identical to Regressions 9.2, 10.2, 11.2, and 12.2 with the exception that the former includes region-interaction fixed effects. Regressions 9.5, 10.5, 11.5, and 12.5 include both region-interaction and industry fixed effects.

Overall, the key variables reveal the expected signs though many are insignificant or marginally significant in magnitude. Results from Tables 11 and 12, which do not include cases involving U.K. firms, reveal a better fit according to expectations. Results show that both domestic and foreign competition factors influence the use of cross-border court litigation; however, different avenues of foreign competition have varying effects.

In all but one specification in both Probit and Negative Binomial models for both sets of results, all three avenues of foreign competition—imports, foreign direct investment, and the number of U.K. affiliates of transnational corporations— reveal a positive correlation to court litigation. Furthermore, the effect of foreign penetration via foreign direct investment and U.K. affiliates of transnational corporations is marginally significant under most specifications. This finding is intuitively reasonable since direct foreign penetration implies physical presence within the home jurisdiction, which

facilitates the initiation of court actions. The results are not as strong when foreign competition exists strictly via imports. The coefficients for the import variable, though positive and mostly marginally significant, are mostly less significant than the foreign direct investment variable. Thus, the ability to utilize court litigation effectively is an important determinant in the likelihood and extent of cases; the physical presence of potential defendant firms within the U.K. increases the ability to take such actions.

The results provide evidence that competition factors play an influential role in the decision process of innovating firms faced with alleged IPR violations. Based on coefficients of the individual penetration variables from Regressions 9.1 and 10.1, an independent one standard deviation increase of each variable (imports, FDI, and foreign affiliates) from its mean (\$51.65 Billion, \$4.40 Billion, and 760) increases the probability of a case by 22%, 26%, and 47%, and the number of cases rises by 0.25, 0.59, and 0.12 (increase of 10%, 24%, and 5% from the mean), respectively. Thus, the effect of the FDI variable dominates the import variable in this model.

In addition to foreign competition, the existence and extent of court litigation in both Probit and Negative Binomial models is positively influenced by market crowdedness within the industry in the U.K., with a significant effect in Regressions 9.2 to 9.4, 10.4, 11.2 to 11.4, and 12.4. Regressions 9.4, 10.4, 11.4, and 12.4 include regional-interaction fixed effects but not industry fixed effects; the coefficients clearly fall when industry fixed effects are added in Regressions 9.5, 10.5, 11.5, and 12.5, suggesting inherent differences between industries in terms of the number of total firms. As the number of firms increases within an industrial sector, the level of competition increases along with the number of potential plaintiffs. And by assuming a constant case-

per-potential-plaintiff ratio, this increases overall court actions, all else equal. In Regressions 9.4 and 10.4, an increase in market crowdedness by one standard deviation from the mean (12,640 firms) increases the probability of a case by 14% and results in 0.14 more cases (6% increase). This finding complements the Lanjouw and Schankermann (2001) finding that market crowdedness increases the likelihood for domestic court actions; in this paper we find that market crowdedness also increases the likelihood and extent of cross-border actions.

The level of technology access is presumed to have an important effect on potential violations and resulting litigation. Regressions in Tables 2-11 and 2-12 (using a sample that excludes U.K. firms) reveal a significantly positive correlation between a plaintiff technology-base in the U.K. and the likelihood and extent of court litigation where fixed effects are excluded. An increase of patent applications by one standard deviation from the mean (approximately 23,000 patents) increases the probability of a case by 52% and results in 0.42 additional cases (22% increase) based on coefficients from Regressions 11.1 and 12.1, respectively. As firms from different regions file patent applications with the U.K. Patent Office, these firms gain a legal basis to file for litigation within the U.K. court system and hence litigation increases. However, the magnitudes are diminished (see Tables 2-9 and 2-10) when cases with U.K. plaintiffs are included. Also, the inclusion of fixed effects lowers the coefficients as well as reverses their signs in all regressions.

This model controls for the level of domestic IPR protection using the Ginarte and Park (1997) composite index with the hypothesis that a higher rating would correspond to a lower likelihood of infringement activities, resulting in fewer cases of litigation. This

variable, however, is never significant. A likely explanation is that each represented region is relatively homogeneous in terms of IPR protection. For example, the average U.K. rating for the two time periods is 3.57 out of 5, the average U.S. rating is 4.36, the average rating for Europe is 3.79, and the average rating for Asia is 3.94. Thus, the slight variation in ratings does not indicate major differences in domestic IPR protection. This result may change if the regions are disaggregated into country-level observations. We do not presently attempt this disaggregation due to data limitations.

Results show consistent significant negative estimates for the time dummy, which takes into account differences in the legal environment affecting the propensity to violate IPR across borders. Holding all other factors constant, the time effect ($t = 1$) results in an average 49% decrease in probability of a case and an average 17% decrease in number of cases per observation based on results from Regressions 9.1 to 9.3 and 10.1 to 10.3, respectively. This decrease is likely attributed to recent legislation to strengthen IPR law via the TRIPS agreement and the Brussels and Lugano Conventions.

Finally, we introduce a new dummy variable in Regressions 9-1 to 9-5 and 10-1 to 10-5 to indicate the 54 observations with a UK-firm as plaintiff (this binary variable is not shown in Equation 2-2 nor in Tables 2-9 and 2-10). Because the inclusion of these 54 observations are the only difference between Tables 2-9 and 2-10 and Tables 2-11 and 2-12, adding a dummy variable allows one to estimate the effect of including observations with UK firms. Results show that in Regressions 9-1 to 9-3 and 10-1 to 10-3 (those without regional-interaction fixed effects), the UK dummy is positive and significant. This result implies that the inclusion of UK firms does in fact affect the results-- UK firms are more likely to file litigation using its own courts, all else equal. In regressions

with regional-interaction fixed effects, the UK dummy becomes insignificant; this finding is likely the result of the fixed effect already picking up the influence of the UK firm.

Conclusions

The use of court litigation is a costly yet popular means of enforcing intellectual property rights (IPR), particularly against foreign-based firms. This paper analyzes litigation patterns within the U.K. by both U.K.-based and foreign-based firms. A model is introduced to investigate factors influencing IPR litigation between four regions competing within the U.K. market for knowledge-intensive goods. We test whether firms within similar industries utilize court litigation as an avenue to protect innovations from competitors as well as to gain market share from those suspected of IPR violation.

The decision to utilize cross-border litigation is influenced by the value of its potential benefits based on competition factors such as industry concentration, imports, and foreign firm penetration, as well as the existence of domestic enforcement mechanisms in the defendant firm's region. The results suggest that litigation, when controlled for asymmetries in IPR protection and access to technology, increased as both industry competition and various avenues of foreign competition rose in the U.K. Specifically, the extent of foreign direct investment and affiliates of transnational corporations into the U.K. increases the likelihood and extent of court actions by all existing firms (both U.K.-based and non-U.K.-based) against the source of the foreign penetration. This finding holds at the industry level and remains robust after controlling for overall market crowdedness and the level of patent stocks within the U.K., along with the level of domestic IPR protection in the defendant region. The underlying reasoning

for these findings is that competition spurs court actions; furthermore, court actions increase when jurisdictional conditions are satisfied.

In the past two decades, the rapid globalization of knowledge-based industries has greatly increased the importance of intellectual property rights protection across national borders. The enforcement of IPR via cross-border court litigation is a leading avenue for dispute resolution between firms, despite the high costs of court litigation. As a result, the decision by plaintiff firms to initiate and pursue court litigation in multi-country cases is contingent on the potential of reaping sufficient returns from such actions. These potential returns are highly influenced by market competition factors facing the firms within their respective industries.

CHAPTER 3

TECHNOLOGY DIFFUSION AND COSTLY KNOWLEDGE SPILLOVERS: A CROSS-COUNTRY ANALYSIS

Introduction

Cross-country technology diffusion is a very important component of the productivity and growth literature. However, a debate has persisted on the mechanism by which knowledge spillovers take place. One theory is that knowledge is a public good, such that once a technology is developed, it becomes part of a global pool that benefits all countries to which the knowledge is relevant. This is the standard assumption taken by many within-country studies (Jaffe, 1986) and cross-country studies (Mankiw, Romer, and Weil, 1992), and is based on the original argument by Arrow (1962) and Nelson (1959). On the other side, it is argued that knowledge spillovers depend on the ability and effort of the recipient party to exploit new technology; in other words, knowledge does not diffuse effortlessly. This theory was applied by Cohen and Levinthal (1989) in their estimation of industrial learning and R&D.

The theory of costly spillovers has gained the attention of growth economists over the past decade. There have been several recent studies that analyze within-country technology transfer. Adams (1999) finds that industrial labs respond to the potential of knowledge spillovers by increasing their investment in “learning expenditures”, which when combined with their own R&D, leads to greater innovation. Technology can also be transferred between federal-funded laboratories and industrial labs, as well as between universities and industrial labs (Adams et al, 2000). In each case, the effort taken by the

recipient party (industrial lab) in terms of learning expenditures or joint research expenditures has a significantly positive correlation with productivity. Further papers have estimated the geographical impediments to knowledge transfer. Studies of both within-country (Adams and Jaffe, 1996) and cross-country (Keller, 2000) spillovers find that knowledge diffusion diminishes with distance. As a result, recipient parties that are farther from the host must devote greater effort and/or expenditures to benefit from knowledge spillovers.

In this paper, we apply the concepts of effort-dependent knowledge spillovers to the recent literature on international R&D spillovers. These studies have largely supported the view that knowledge is embodied in international trade, and therefore countries that trade extensively with R&D intensive countries will benefit the most from foreign technologies (see Coe and Helpman 1995, Coe, Helpman, and Hoffmaister 1997). However, a limitation of these studies is the dependency of knowledge transfer on trade (so-called rent spillovers). Although we do not refute the importance of trade as an important channel of technology transfer, we must consider the existence of other mechanisms, which Griliches (1979) calls *pure knowledge spillovers*. Xu and Wang (1999) find that a majority of international technology spillovers can be attributed to factors other than trade. Today, this argument applies to the plethora of information that is conferred in disembodied forms, including patent applications, scholarly journals, multinational firms (FDI), international faculty and conferences, and also the Internet.

The purpose of this study is the categorical investigation of major channels to which non-OECD countries obtain foreign technology. First, there is knowledge embodied in imported goods (rent spillovers), and more specifically, that of capital-

intensive goods. Secondly, information can be obtained in various disembodied forms (pure knowledge spillovers). We present a productivity model that attempts to simultaneously capture both trade-embodied and disembodied channels for technology diffusion. To represent the latter, we form a patent knowledge stock using bilateral patent flow data.

The establishment of the mechanisms by which technology is diffused is just the first part of the analysis. The remainder, and equally important, is the determination of the extent of knowledge transfer. Different countries of similar size and characteristics exhibit large differences in foreign technology absorption. The ability to absorb foreign technologies is often attributed to human capital formation in the recipient country. In addition, we must consider other factors that facilitate or impede the introduction of foreign technologies into a country; these include the level of intellectual property rights (IPR) protection and the openness to foreign investment/influences.

An important policy aspect is that each individual country influences the measure of these factors based on the actions of its residents and governing bodies. For example, in order to increase IPR protection or foreign investment inflows that may lead to future benefits, a country may need to have an initial sacrifice, one that is frequently too costly for lesser-developed countries. For example, lesser-developed countries find it difficult to increase pharmaceutical patent protection due to the potential short-run ramifications on the health of its residents as drug prices rise. Such initial costs and effort can be overly burdensome and therefore lead to weaker IPR protection.

In order to test these premises explicitly, we form two reduced-form patent equations in order to determine how effort-dependent factors may influence the rate of

innovation and therefore ultimately the level of productivity growth. Our findings support the view that countries may effectively promote future innovation and growth if they are willing to advocate policies that may be costly in the short-run, but result in positive long-run returns.

Framework

Productivity and Growth Equations

Our model begins with a Cobb-Douglas production function in which output (Y) is produced using labor (L), physical capital (K), and knowledge (S); thus, $Y = A(e^{\mu H}L)^{\alpha}K^{\beta}S^{\gamma}$, where the effective labor supply ($e^{\mu H}L$) is adjusted for human capital (H) (included to account for domestic abilities and knowledge). Total factor productivity (TFP) is defined as $F = Y/L^{\alpha}K^{\beta}$; combining equations, we have $F = Ae^{\mu H}S^{\gamma}$. The level of knowledge (S) is generated from both domestic (S_p^d) and foreign sources; in addition, foreign knowledge can be assimilated through trade (S_m^f) and pure direct transfer (S_p^f) which we measure by foreign patents.

We construct the following equation:

$$\log F_{it} = \alpha^0_{it} + \alpha^1_{it} \log S_{p,it}^d + \alpha^2_{it} \log S_{m,it}^f + \alpha^3_{it} \log S_{p,it}^f + \alpha^4 \log H_{it} + e_{it} \quad (3-1)$$

where i and t are indices of country and time, respectively; α^1_{it} , α^2_{it} , and α^3_{it} are the elasticities of TFP with respect to domestic knowledge stock, foreign knowledge in imports, and foreign knowledge in patents. In order to estimate productivity growth, we take the first difference of Equation (3-1) and obtain the following difference equation:

$$\Delta \log F_{it} = \alpha^1_{it} \Delta \log S_{p,it}^d + \alpha^2_{it} \Delta \log S_{m,it}^f + \alpha^3_{it} \Delta \log S_{p,it}^f + \alpha^4 \Delta \log H_{it} + \lambda_{it} \quad (3-2)$$

Innovation Equations

When a firm faces an opportunity to market a product in a developing country, it chooses between direct exportation or market-site production through foreign direct investment (FDI). In both cases, patenting is an important tool as the revenues of the firm depend on the ability to sell products without the threat of competitive imitations.

Our first reduced form equation attempts to characterize the role of intellectual property rights (IPR) on foreign patenting among non-OECD countries. Previously, Eaton and Kortum (1996) have estimated a positive correlation between IPR protection and foreign patenting among OECD countries. Yet, a limitation in their analysis is that their measure of IPR protection is confined to two values, lesser protection and greater protection. In our model of non-OECD countries, the data allows us to assign a level of IPR protection (between zero and five, in decimal form, taken from the Maskus and Penubarti, 1995) that provides more precise variation between countries. In addition to IPR protection, we estimate the influence of trade and FDI on foreign patenting.¹ The model controls for both overall and capital-intensive trade, as well as a country's inflow of FDI. These variables are chosen because they involve the interaction of new technology and products from R&D intensive countries that lead to increased knowledge transfer by way of foreign patenting. Using the variables described, we construct the following foreign patent equation:

$$\log P_{it}^f = \alpha^0_{it} + \alpha^1_{it} \log \text{OPEN}_{it} + \alpha^2_{it} \log \text{FDI}_{it} + \alpha^3_{it} \log \text{K-IMP}_{it} + \alpha^4_{it} \log \text{IPR}_{it} + e_{it} \quad (3-3)$$

¹ In earlier work, Maskus and Penubarti (1995) estimated a positive relationship between IPR protection and the level of capital-intensive trade between countries. Mansfield (1993) shows that FDI is positively correlated with perceptions of IPR protection. A common feature in these studies is the ability and willingness of developing countries to attract foreign capital by assuring that new innovations will be protected by a universal standard of IPR protection.

where P_{it}^f represents aggregate inflows of foreign patent applications, $OPEN_{it}$ is the sum of total imports and exports, FDI_{it} is total inflow of foreign direct investment, $K-IMP_{it}$ is the total imports of capital-intensive goods, and IPR_{it} is the Maskus and Penubarti index of the overall state of IPR protection. Each variable is measured according to Country i and Time t .

Our final equation estimates the impact of foreign knowledge spillovers on domestic patenting. In particular, we test for the complementarity of domestic and foreign R&D. We hypothesize that given the technology gap between OECD and non-OECD countries, the catch-up effect should allow non-OECD countries to reap greater benefits from foreign technology given a level of absorptive capacity. The following equation is proposed:

$$\log P_{it}^d = \alpha^0_{it} + \alpha^1_{it} \log S_{it}^d + \alpha^2_{it} \log P_{it}^f + \alpha^3_{it} \log S_{it}^f + \alpha^4_{it} \log FDI_{it} + \alpha^5_{it} \log H_{it} + e_{it} \quad (3-4)$$

where P^d and P^f are domestic and foreign patent flows, respectively; S^d and S^f are domestic and foreign R&D capital stocks, respectively. We test this equation with both an OECD and a non-OECD sample in order to uncover similarities and differences in the determinants of patenting.

Data

One of the primary reasons for the relatively few empirical studies for non-OECD countries is the lack of complete and reliable data. Indeed, the availability of high quality capital stock data limits the sample selection to countries whose data can be reconciled among reliable sources. Even allowing for subtle inconsistencies, our sample consists of

15 non-OECD countries (see Appendix B) from the year 1981 to 1990. This time frame was chosen to coincide with preceding studies.²

For this paper, data on capital stock are found in the Penn World Tables (PWT, Mark 5.6); in addition, these data are utilized along with labor force and real GDP data to compute total factor productivity (TFP) for non-OECD countries.³ Because information on factor shares is not available, a constant capital share of 0.3 is assumed for all countries and TFP is computed using a Cobb-Douglas production function.

Data on patents are obtained from the World Intellectual Property Organization (WIPO) publication *Industrial Property Statistics* that provides the number of patent applications by residents (domestic patents) and non-residents (foreign patents) beginning in 1963. Using this annual flow data, we calculate domestic (S_p^d) and foreign patent (S_p^f) stocks using a depreciation rate of 15% (details on the construction of patent stocks can be found in Appendix B).

A measure of foreign spillovers embodied in trade (S_m^f) has been used by Coe and Helpman (1995) (see Appendix B for details). We adopt this approach in our model; however, we modify the trade shares by using capital goods trade data found in the OECD's *Foreign Trade by Commodities*. This approach is used by Xu and Wang (1999) who find it to be a better measure of trade-embodied R&D diffusion.

² We do have data as current as 1996 for all variables except foreign capital stock from trade, which we take from Coe and Helpman (1995) and Coe, Helpman, and Hoffmaister (1997). Because the spillover effect from trade is an integral component of Equations 3-1, 3-2, and 3-4, we limit the time span to 1981 to 1990 in order to use foreign capital from trade for these equations. However, because our foreign patent equation (Equation 3-3) is not dependent on this effect, we use a more recent data range (1989 to 1996) in order to avoid large inconsistencies in the data.

³ Inconsistent data on labor and GDP were reconciled using the World Development Indicators Database.

Bilateral trade data are available from the *United Nations' Handbook of International Trade and Development Statistics* for 1989 to 1997. Data on foreign direct investment is found in *IMF's International Financial Statistics Yearbook* for 1980 to 1998. We construct the variables $OPEN_{it}$, $K-IMP_{it}$, and FDI_{it} using these data.

Data on human capital are found in Barro and Lee (1996). We measure human capital by the average years of secondary school attainment among males. This measure is a better measure of human capital than school enrollment rates, which are available for more countries.

Finally, our study uses an index of IPR protection initially developed by Rapp and Rozek (1990). The index ranges from 0 to 5, with higher ratings indicating stronger protection. Because of the subjectiveness of the ratings, Maskus and Penubarti (1995) used an instrumental variables approach to update the Rapp and Rozek index in order to reduce measurement errors. In our models, we use the Maskus and Penubarti index to represent a country's level of IPR protection.

Empirical Findings

Each of the equations in this study is estimated using the standard OLS method. In Table 3-1 both level and difference regression results for the productivity equation are reported; however, the discussion will focus on the difference results. This is because the multicollinearity is more of a problem in the level regression.

We find that the domestic patent stock variable is mostly insignificant; this is not surprising since non-OECD countries possess very limited R&D sectors.⁴ As a result, productivity growth by non-OECD countries is significantly influenced by knowledge

⁴ It is estimated that non-OECD countries account for less than 5% of world R&D.

Table 3-1: Ordinary least squares estimation of total factor productivity in non-OECD countries; level and difference regressions (yearly samples)

Dependent Variable = $(\Delta)\log TFP$				
Regression #	1.1	1.2	1.3	1.4
Specification	Level	Difference	Level	Difference
(Δ)Log(Domestic Patent Stock)	0.125 (2.65)***	0.059 (1.17)	0.053 (1.17)	0.030 (0.66)
(Δ)Log(Trade-weighted For. R&D Stock)	0.127 (1.93)*	0.225 (2.42)**	-0.087 (-1.03)	0.030 (2.55)**
(Δ)Log(Foreign Patent Stock)	0.127 (3.42)***	0.071 (1.68)*	0.071 (2.56)**	0.062 (1.66)*
Log(Capital-Goods Imports)	---	---	0.001 (4.96)***	0.008 (2.44)**
(Δ)Log(Human Capital)	0.035 (0.62)	0.006 (0.07)	-0.155 (-2.26)**	-0.022 (-0.25)
# of observations	150	135	150	135
Adjusted R ²	0.9794	0.1008	0.9839	0.1393
Root MSE	0.0740	0.0530	0.0660	0.0521

Notes: a "level" specification refers to the estimation of equation 1; a "difference" specification refers to the estimation of Equation (3-2). The subscript 'm' refers to R&D capital stock data that is diffused through the import of capital-intensive goods. The trade-weighted foreign R&D variable is formed using the overall ratio (m) of imports to GDP. T-statistics are in parentheses. Country fixed effects are used in the level regressions; however, fixed effects constants are not reported. The time period for this model is 1981 to 1990. *, **, and *** represent the significance levels of 10%, 5%, and 1%, respectively.

transfers from OECD countries. We find that both foreign knowledge stocks—the R&D spillovers from trade as well as from patents—are significant. These findings support the hypothesis that knowledge spillovers occur through multiple channels, where trade and patents are two such channels. Finally, the human capital variable is found to be insignificant, contrary to initial beliefs. However, the reader is referred to Benhabib and Spiegel (1994), who argue that human capital itself is not a productive input; instead, human capital enhances other variables which do increase productivity.

The results from the foreign patenting equation are shown in Table 3-2. This model attempts to substantiate the various motives and factors that influence foreign patenting. In particular, trade in capital-intensive goods is found to have a higher correlation to foreign patenting than overall openness to trade; this is expected since capital-intensive goods depend highly on patent protection for their success in the given market. Furthermore, a higher level of IPR protection encourages more patenting because it provides innovators a sense of security in their decision to disclose their innovations.

Regressions 2.1 and 2.2 show the effects of IPR protection on foreign patenting. In the latter, the inclusion of IPR protection renders general openness to trade insignificant, though openness to capital-intensive trade remains robust. We can infer that a certain portion of total trade is due to IPR protection. Hence, the significance of $OPEN_{it}$ in Regression 2.1 is the result of capturing the effects of the omitted variable. Once IPR is controlled for, we obtain our expected result.

Regression 2.3 shows how the results change when we interact IPR_{it} with $\log FDI_{it}$ and IPR_{it} with $\log K-IMP_{it}$. This is to highlight how FDI and imports are influenced by

Table 3-2: Ordinary least squares estimation of foreign patenting in non-OECD countries

Dependent Variable = Log of Foreign Patenting			
Regression #	2.1	2.2	2.3
Log(Imports + Exports)	0.860 (2.22)**	0.172 (0.46)	0.135 (0.80)
Log(FDI)	-0.141 (-1.00)	-0.109 (-0.85)	---
Log(Capital-Goods Imports)	0.974 (3.19)***	1.102 (3.96)***	---
Maskus-Penubarti	---	1.301 (5.21)***	12.900 (12.81)***
Maskus-Penubarti x FDI	---	---	0.205 (1.62)*
Maskus-Penubarti x Log(Cap-Goods Imports)	---	---	1.914 (11.77)***
# of observations	120	120	120
adjusted R ²	0.5080	0.5983	0.7978
Root MSE	1.2895	1.1701	0.8301

Notes: Log(Imports + Exports) is calculated by the sum of total imports and exports with all trading partners; LogFDI is the log of total foreign direct investment from all source countries; Log(Capital-Goods Imports) is the log of total dollar value of capital goods imports. Maskus-Penubarti is a variable from 0 to 5 which accounts for the overall measure of IPR based on Maskus and Penubarti (1995). T-statistics are in parentheses. The time period for this model is 1989 to 1996. *, **, and *** represent the significance levels of 10%, 5%, and 1%, respectively.

IPR protection. Using this specification, there is a positive correlation between FDI and increased patenting. This is consistent with Mansfield's (1993) finding that there is a positive relationship between the perception of IPR protection and the level of FDI. In addition, we find that the effect of IPR protection on foreign patenting is greater in countries that import larger quantities of capital-intensive goods.

Table 3-3 contains results for the domestic patenting equation. This equation estimates the influence of foreign spillovers on the frequency of domestic patenting.⁵ The results are mostly consistent with expectations. As expected, both foreign spillover variables have a larger effect in the non-OECD sample than in the OECD sample.⁶ Furthermore, we find that foreign patenting is a *significant* catalyst to domestic innovation and patenting in non-OECD countries. This result coincides with our earlier finding that developing countries depend more on foreign innovation, especially from the OECD, in order to draw upon and initiate their own patenting.⁷ However, this result does not hold in the OECD sample, where domestic R&D is sufficient to drive innovation and patenting.

In Regressions 3.1 to 3.6, domestic R&D has a significant positive impact on domestic patenting. However, Regression 3.7 supports an argument that refutes the significance of domestic R&D in non-OECD countries. Although there may be

⁵ An important note here is that despite the incidence of domestic patenting in non-OECD, this does not necessarily imply higher productivity growth as shown in our productivity results. Nonetheless, we choose to include this regression as a comparison between OECD countries (where domestic patents do increase productivity) with non-OECD countries. As non-OECD countries develop, we might uncover a growing significance of domestic patenting.

⁶ The OECD sample consists of the 22 countries used by Coe and Helpman (1995) with the omission of Israel, which is not an OECD country.

⁷ It is important to clarify that even though the foreign patent variable is measuring patents from all countries, the majority of foreign patenting originates from OECD countries.

Table 3-3: Ordinary least squares estimation of domestic patent flows

Dependent Variable = Log of Annual Domestic Patent Flows							
Regression #	3.1	3.2	3.3	3.4	3.5	3.6	3.7
Sample	Full	OECD	non-OECD	OECD	non-OECD	OECD	non-OECD
Log(Domestic R&D)	0.868 (9.17)***	1.156 (7.32)***	0.257 (3.29)***	1.291 (9.26)***	0.280 (3.34)***	1.774 (9.74)***	0.261 (1.04)
Log(Foreign Patents)	0.024 (0.34)	-0.076 (-0.69)	0.232 (1.88)*	-0.004 (-0.04)	0.240 (1.94)**	---	---
Log(Foreign R&D)	0.035 (0.30)	-0.235 (-1.32)	0.190 (0.90)	-0.479 (-2.89)***	0.171 (0.80)	---	---
Log(DomR&D) x Log(For Patents)	---	---	---	---	---	-0.004 (-0.04)	0.240 (1.94)**
Log(DomR&D) x Log(For R&D)	---	---	---	---	---	-0.479 (-2.89)***	0.171 (0.80)
Log(HumanCap)-0.110 (-0.51)		-0.109 (-0.30)	0.509 (1.47)	-0.106 (-0.36)	0.525 (1.48)	-0.106 (-0.36)	0.525 (1.48)
LogFDI	0.012 (0.54)	0.082 (2.76)***	0.010 (0.29)	0.036 (1.52)	0.014 (0.35)	0.036 (1.52)	0.014 (0.35)
Log(Capital-Goods Imp)	---	---	---	0.145 (2.20)**	-0.102 (-0.77)	0.145 (2.20)**	-0.102 (-0.77)
No. of obs.	360	210	150	210	150	210	150
Adjusted R ²	0.9783	0.9778	0.9682	0.9906	0.9684	0.9906	0.9684
Root MSE	0.3734	0.3226	0.3820	0.2068	0.3832	0.2068	0.3832

Notes: Domestic R&D and Foreign Patents are measured as stock variables. Foreign R&D is the log of trade weighted foreign R&D stock; logFDI is the log of total foreign direct investment inflows, using IMF data. T-statistics are in parentheses. Country fixed effects are used in the level regressions; however, fixed effects constants are not reported. The time period for this model is 1981 to 1990. *, **, and *** represent the significance levels of 10%, 5%, and 1%, respectively.

measurement problems in regard to actual R&D expenditures, the literature suggests that domestic R&D in the non-OECD is sufficiently negligible such that it should have minimal bearing on a country's aggregate productivity (Coe, Helpman, and Hoffmaister, 1997). In our model, we test this by interacting domestic R&D with foreign patenting. We find that though domestic R&D continues to be robust in the OECD, it becomes insignificant in the non-OECD. This finding suggests that domestic R&D in developing countries may not be a primary determinant of domestic patenting; however, domestic R&D that complements the inflow of foreign patents does increase patenting.

Conclusion

The growth of international technology can be analogized to galactic space: it continues to grow without bound, yet the benefits are reaped only to the extent that we are willing to exploit it to our benefit. This conclusion is influenced by the endowment of resources as well as the capability to absorb new knowledge. Developing countries often face difficult challenges in bridging the technology deficit with developed countries. The reasons can be wide-ranging, from the economic argument of scarcity to the apprehension of cultural change. In certain cases the inability to advance is the result of an inefficient government. However, this and other studies have shown that technology can and does flow between countries through various channels.

This paper estimates the importance of capital-goods trade as well as foreign patenting to the aggregate growth in productivity, and finds that both sources are concurrently significant. Furthermore, we identified various factors that affect the extent of foreign patenting in a country. Thus, the global pool of knowledge can ultimately allow non-OECD countries to converge to a higher state of growth. However, the

determining factor ultimately lies with the country itself—its ability to manage domestic and foreign affairs, to allow and encourage foreign direct investment, to strengthen laws that protect intellectual property, to invest in education and encourage international scholastic relations, and to promote trade with capital-intensive nations.

APPENDIX A
THE IDEAL INTELLECTUAL PROPERTY ENFORCEMENT MECHANISM:
CHOOSING BETWEEN CROSS-BORDER COURT LITIGATION AND USITC
TRADE SANCTIONS

Introduction

The seminal legal mechanisms for the protection of Intellectual Property Rights (IPR) began with the Paris Convention (1883) and the Berne Convention (1886) for the protection of patents and trademarks, respectively. Over the past century, numerous additional treaties were introduced in order to allow the enforcement of IPR to stay current with the needs of the world. In the past three decades, the importance of IPR has risen significantly as a result of the new “Information Age” and more recently the use of the Internet. Currently, the value of information has become paramount to many firms and organizations, and the protection of IPR has grown to include active measures of its enforcement, particularly against alleged violations that occur outside of the innovator’s country. This paper compares the various enforcement mechanisms available to IP rights owners against alleged foreign violations. Specifically, we compare the differences, as well as advantages and disadvantages, between traditional court litigation and the use of alternative complaint mechanisms with the United States International Trade Commission (USITC), the World Intellectual Property Organization (WIPO), and the World Trade Organization (WTO).

Treaties and Laws of the Past Century

Although throughout history man has attempted to protect innovations by various laws carried out by groups of people, it has always been a difficult to impossible task to protect innovations across national borders, or sometimes even across cities and villages. The first worldwide IPR treaty was the Paris Convention, established in 1883. This was an open treaty to any country wishing to join, and calls for the protection of innovations (patents) by all member nations. This treaty also established the application of foreign patents, which enables nations to protect the innovations of other nations. In 1886, a similar treaty was created to protect trademarks, named the Berne Convention. Over the past century, nearly all treaties have been based upon these initial Paris and Berne Conventions. Many of these were updates to allow for changes in the world economy and cultural changes.

The Trade-related Aspects of Intellectual Property Rights (TRIPS) was developed and implemented by GATT members during the 1994 Uruguay Rounds. The agreement officially went into force on January 1, 1995.¹ The TRIPS agreement calls for the phase-in of stronger protection and enforcement of IPR in many countries, particularly in developing countries, where stronger IPR protection encourages more foreign direct investment and technology transfer. It also encourages industrialized countries to fully recognize patents of member countries, and to enforce them with a harmonized and fair manner.

¹ Although TRIPS officially went into force in 1995, an agreement between the WIPO and WTO calling for cooperation in the implementation of TRIPS did not take effect until January 1, 1996.

International IPR Litigation Framework under the Brussels/Lugano Conventions

The Brussels Convention was established by the European Economic Community (EEC) on September 27, 1968, with major amendments instituted with the Act of 1988.

The primary purpose of the Brussels Convention was to establish that defendants of a member country cannot resist court litigation and enforcement of a crime commenced by a foreign plaintiff simply by claiming the lack of jurisdiction by the plaintiff. However, it remains the general rule that a defendant must be sued in their country of domicile. The Lugano Convention was established on September 16, 1988, and follows similar provisions as the Brussels Convention, with the key difference being that the Lugano Convention is to be followed when a member country of the European Free Trade Agreement (EFTA) is involved (Norway, Iceland, Switzerland, and Liechtenstein).

The essence of international IPR litigation is that an alleged IP violator must be sued in its home country. However, there are exceptions if the damages of the act take place in a different country. In such cases, it may be possible to be sued in a country other than its home country. This relates to the jurisdiction of the court—a court must have personal and subject-matter jurisdiction. Personal jurisdiction is the extent to which an alleged IP violator is physically present in the country during the violation. Subject-matter jurisdiction is the ability of the court to hear cases when its country's law is violated—i.e. a foreign entity has infringed a country's IP right causing damages to the IP rights owner in a country. This is true for patent infringement cases, copyright/design, and trademark infringement cases.² In these cases, a plaintiff may sue a defendant in a

² The exception is for passing off cases, which is not governed by a specific IP act, but rather treated as part of the common law.

jurisdiction where the plaintiff has suffered damage due to the defendant's action, even if the defendant has never operated in the plaintiff's jurisdiction. In regards to foreign infringement, a foreigner can be sued as long as there is significant damage (but not necessarily all) within the court jurisdiction. In addition, interlocutory (temporary) injunctions can be granted against infringements that take place where the damages occur, even if the trial does not take place there. Finally, if a trial occurs in the defendant's home country, a plaintiff can sue in regards to every infringement of IP rights, including both domestic and foreign IP rights.

A special case arises when there are secondary foreign defendants: entities that unintentionally violate an IP right by association with a domestic entity that violates the IP directly. In such cases, actions of litigation must be brought against the domestic defendant first. However, if the foreign entity is directly affiliated with a domestic entity that violates an IP, then the foreign entity can be sued directly.

A normal criterion for court litigation is that a country's IP right, and not a foreign IP right, be violated in order for the court to hear the case. However, some countries have been known to allow cases regarding foreign IP rights, especially if the foreign IP right is from another member of the EEA. German courts have taken actions for violations of IP rights from other EEA countries. Dutch courts have gone beyond this to take actions for violations from EEA and non-EEA countries. Note that usually the defendant in these actions is also from the same country as the court. Thus, a Dutch court may hear a case where a US firm sues a Dutch firm for violating a US IPR. However, in cases where the alleged violator is an entity in a foreign country, a court cannot usually

establish jurisdiction. In such cases, it may be necessary to pursue litigation in the defendant's country, though in many countries effective litigation is not available.

Court Structure of the United Kingdom

The court structure of the United Kingdom begins with the House of Lords (HL) and the Privy Council (PC). There is a Court of Appeals (CA), with a Criminal and a Civil Division. Next is the High Courts of Justice, which is divided into three divisions: Chancery (ChD), Queen's Bench (QBD), and Family. Within the Chancery Division of the High Court, there exists a specialized Patent Court (PatCt). Finally, there exist lower courts, including that of the Patent County Courts (PCC).

The majority of litigation regarding intellectual property occurs in the Chancery Division of the High Court, with cases involving patents given to the Patent Court. All appeals to these proceedings are then litigated in the Court of Appeals. In certain circumstances, cases may be commenced in the House of Lords, the High Court Queen's Bench Division, and in the Patent County Courts. In regards to court transfers, a High Court may transfer a case to a PCC, but cannot transfer a case commenced at PCC to the Patent Court. Outside of England, there exists the Court of Justice of the European Community (ECJ), as well as the Supreme, Federal, and District Courts of the individual members of the European Community.

USITC

The United States International Trade Commission (USITC) serves as the primary ombudsman for U.S. companies to file official investigations against entities in foreign countries for alleged violations of intellectual property rights. Section 337 is the filing number established to handle investigations for these purposes. Since 1972, 448

individual cases have been filed under this code. The past few decades have proven to be a dynamic revolution in intellectual property rights. The composition of research and development has experienced a dramatic move towards “intellectual goods”, such as high-tech computer microprocessors, pharmaceuticals, and software products. Never before has the growing need for intellectual property protection been as prevalent as it is for today’s growth of intellectual goods, which have proven to be very profitable if re-engineered or reproduced without the consent of the property right owner. As a result, various international negotiations in the past 20 years have begun to focus on creating a universal standard of intellectual property right protection. Nevertheless, the state of the world in such an endeavor is still in its infancy stages. However, with each new international negotiation, more and more countries are committed to a general standard of protecting intellectual property.

Section 337 Background

Section 337 originated from the Tariff Act of 1930, though modern investigations did not commence readily until around 1972. The majority of Section 337 investigations involve the alleged infringements of patents, copyrights, or trademarks.³

In order to file a complaint under Section 337, a firm or individual (complainant) must file a petition with the USITC Office of Unfair Investigations, clearly indicating the violating party (respondent) and the specific IPR suspected in infringement. As long as the filing conforms to USITC rules, an Administrative Law Judge is assigned to preside over the proceedings. Within 30 calendar days, the USITC votes on whether a full

³ Industry Trade Secrets (knowledge held by company employees) also fall broadly into Section 337; however, trade secret violation via cross-country labor movements is not very prevalent.

investigation is warranted. If so, hearings begin to take place at the Commission.

Generally, it takes about 9 months for the Administrative Law Judge to present its "Initial Determination". Without an appeal by any party, this decision is final; however, any party may petition for a review of any portion of the Initial Determination, which is then subject to potential modification. Generally, the case is fully closed approximately one year from the initial complaint. In terms of restitution, monetary awards are not permissible under Section 337; instead, exclusionary orders are usually granted to prevent further infringed products from entering the country. Such restrictions are enforced by U.S. Customs when clearing imports from abroad.

Jurisdictional Issues Under Section 337

Because Section 337 Investigations fall under US law and under the legal jurisdiction of the USITC, jurisdictional issues are less of a concern than in cross-border court litigation cases. However, it is possible that conflicts may still arise between parties in regards to the justification of the investigation. For example, if Country x does not recognize a firm's patent in Country y as valid, then a firm in Country x is not legally violating a IP right. Yet, because it violates Country x's IP right, Country x may take action to block imports from the firm in Country y. Although the firm from Country y may appeal, ultimately there is nothing it can do, because the enforcement measures (the blocking of imports) are fully executed within Country x.

Another potential situation is the occurrence of secondary violations. For example, Country y freely trades with country z in a good that violates a patent in Country x. However, neither Country y nor Country z recognizes the patent. Assuming that a distributor in Country z ships infringing goods to Country x, should the action be

taken against the firm in Country y or Country z, the point of origin or the point of last transit? The answer is relatively straightforward in this case; because Section 337 is a broad mechanism, multiple respondents can be named in any single investigation. In our example, both firms in Country y and Country z can be named, and pending the investigation, sanctions could be assessed on both firms.

Key Differences between Court Litigation and USITC Mechanisms

The choice of enforcement mechanisms entails the comparison of key differences between available avenues. Differences between the use of court litigation and the USITC mechanism are outlined in Table A-1. A majority of differences between the two mechanisms revolves around procedural differences that ultimately affect the parties involved. The following discusses each difference in turn.

Courts: A key difference between court litigation and USITC mechanism is the venue of the proceedings. Under most jurisdiction rules, a presiding court must establish both personal and subject-matter jurisdiction in order to hear a case. Therefore, the hearing of most cross-border IPR court cases occurs in the courts of the defendant country. These exceptions include the existence of domestic subsidiaries of the foreign firm, other forms of domestic presence of the foreign firm, or multi-country court treaties that enable a defendant firm to be tried in the plaintiff country. Under current rules, USITC cases are tried by an administrative judge in the USITC court, which has legal jurisdiction for all cases filed under this law.

Laws: Under court litigation, all defendants must be guilty of a law that is legally binding to them under its jurisdiction. For example, a Canadian firm cannot be tried under U.S. laws unless jurisdiction is established to this regard. For USITC

Table A-1: Key differences between US litigation and USITC investigations

Variable	Litigation	USITC Investigations
Courts	Based on court jurisdiction according to parties and subject matter involved	Centralized authority to determine investigations
Laws Involved	The defendant must have violated a law that is legally binding to them	Investigations follow U.S. laws, regardless of the respondent party
Time Frame	Litigation generally averages over one year, plus time for appeals	Investigations generally concluded 1 year from application
Sanctions	Monetary Damages can be awarded in addition to Trade Injunctions	Limited to Import Trade Sanctions against violating party; enforced by Customs
Interlocutory Injunctions	Allowed if sufficient evidence is presented	Allowed if sufficient evidence is presented
Appeals	Fed Court of Appeals	Fed Court of Appeals
Settlements	Rarely reached once litigation phase begins	Highly encouraged and generally used
Success of Cases	Approximately half of cases in favor of plaintiff and half in favor of defendant	A majority of investigations results in settlement or in favor of the complainant
Nationality of Defendant Party	Either the defendant or a subsidiary of a foreign parent will reside in the country of the court	Highly Concentrated in Countries with large manufacturing and export economies
Industries	Presence of Chemicals, Pharmaceuticals, Other Manufactures, and Services	Highly concentrated in Machinery, Manufactures, and Electrical goods
Year of Cases	Grown steadily as new laws allow for easier cross-border litigation	Peaked in the 1980s, with a drop in the 1990s
Type of Cases	Patent, Copyright, Trademark, and Passing Off Cases	Primarily Patent Cases as they are usually tied to manufacturing and trade
Costs and Consequence	Lawyer/Court fees can be prohibitive; a strong defense could result in the annulment of IPR - a backfire result	Costs primarily involve paperwork of proving damages resulting from infringement

investigations, all cases are tried under U.S. law, which naturally puts defendant firms at a disadvantage. However, the level of sanctioning power is largely limited under the USITC court.

Sanctions: Under both mechanisms, the use of interlocutory (temporary) injunctions (such as the prohibition of sales of goods in question) is allowed as long as sufficient evidence is presented. In terms of final judgment, court litigation can result in standard compensatory and punitive damages along with exclusionary orders. For USITC claims, sanctioning power is limited to exclusionary orders, specifically the blocking of imports from the violating firm.

Time Frame: A majority of all USITC cases are fully concluded, including any appeals, within one year from the initial application. Court litigation cases often proceed over several years, and possibly several additional years for appeals and cross-appeals.

Success Rate: Because the USITC mechanism tends to be lenient towards US firms, the success rate is approximately 75%. A successful case is defined as any result favoring the plaintiff, including a judgment of violation, along with approved settlement and consent agreements. Court litigation results in a success rate of approximately 50% for all initial hearings. However, nearly all judgments are appealed at least once, but the success rate of appeals is generally very low.

Costs and Consequences: The primary fees involved with USITC cases are largely administrative. Lawyer fees do exist, but primarily in the preparation of cases to be heard by an administrative judge. Typical courtroom interaction between lawyers is limited. On the other hand, court litigation cases can involve significant lawyer fees

along with large administrative costs. Furthermore, the frequent use of defendant counter-actions, including the annulment of an IP right, can be a costly loss to a plaintiff.

Conclusion

The choice between enforcement mechanisms by firms facing cross-border violations of IPR largely entails the careful analysis of the best-fit mechanism to its particular circumstance. In many cases, the use of court litigation, which is the most costly and risky approach yet potentially the most rewarding, is the most effective means of enforcement. However, in many cases of cross-border IPR violations, the use of foreign courts is useless, and therefore, alternative mechanism must be consulted. The USITC mechanism has proved popular among US firms facing intense import competition from alleged IP violators, with the sanctioning power being the use of exclusionary orders that help to generate market share for the domestic firm.

Finally, if both court litigation and USITC mechanisms are not effective, there are several organizations that may be consulted, the WTO, WIPO, and USTR. The World Trade Organization will only hear complaints by member countries; however, it has been common for a group of firms (i.e. pharmaceutical firms) to make a country-level complaint against a foreign country. The World Intellectual Property Organization has a mediation and arbitration center, which helps to resolve disputes between firms, generally those that already have a business relationship, and therefore would like to resolve their disputes in an amicable manner rather than in a courtroom. Finally, the United States Trade Representative hears complaints by U.S. firms for unfair trade practices, including alleged IPR violations. These complaints are filed and published in USTR reports; however, little or no action is ever pursued in their regard.

In conclusion, navigating through the many elements of IPR enforcement is a difficult problem facing innovating firms. In an ideal world, there would be a universal system of IPR laws, their interpretation, implementation, and enforcement. However, establishing such a system would likely entail the globalization of not only vastly different economic systems, but also cultural differences, a feat that is not likely to be welcomed by most nations. As a result, it is necessary to accept the differences in current law, and for firms to pursue measures that would bring about the most effective and beneficial outcome.

APPENDIX B APPENDIX TO CHAPTER 3

This chapter utilizes a variety of data sources. TFP is calculated using data from Penn World Tables (Mark 5.6). Using the data, $TFP = Rgdpw/Kapw^{0.3}$, where $Rgdpw$ is real GDP per worker and $Kapw$ is capital stock per worker, both in constant 1985 dollars.

To construct s_p^d (domestic patent stocks), annual data on patent application flows (p^d) are used beginning in year 1963. Patent flow in 1963 is specified as p_0 . Using p_0 , the initial patent stock s_0 is created using the approach by Griliches (1980). Thus, $s_0 = p_0 / (g + \delta)$, where g is the average growth rate of the first 10 years of available data, and δ is the depreciation rate, set at 15%, a common rate used for discounting patent flows, which generally depreciate faster than R&D expenditures (see Adams, 1999). For all remaining years, the patent stock is specified as $s_t = (1 - \delta)s_{t-1} + p_{t-1}$, where p_{t-1} equals the patent flow for the previous year. Missing data are interpolated using the midpoints of neighboring data. For missing initial year data, an estimate is generated using the average growth rate for the first 5 available years of data. A total of 32 data points out of 1008 entries are estimated utilizing these methods.

Foreign patent stocks, s_p^f , are also constructed from annual data beginning 1963. The data found here is the *total* number of patent applications (p^f) from *all* foreign countries. Using this data, foreign patent stocks are constructed in the same manner as s_p^d . Inconsistencies found in the WIPO data are corrected using the OECD *Basic Science*

and Technology Statistics, which contain data for more recent years. Finally, 13 missing observations are interpolated.

The data for domestic OECD R&D capital stock, s^d_t , are taken from Coe and Helpman (1985). These indexed data are converted into value data with 1985 = 1 and the actual value data provided for 1990. The value of domestic R&D capital stocks is in U.S. dollars, based on PPP's and in constant 1985 prices.

Data on domestic non-OECD countries are taken from *UNESCO Statistical Yearbooks* (1980 to 1999). Because complete data series are limited for non-OECD countries, R&D expenditures are estimated by multiplying the total number of R&D workers (if available) by the R&D expenditure per researcher (occasionally interpolated) for the corresponding country. Remaining missing observations are fully interpolated.

The foreign R&D spillover variable (s^f_m) was first used by Coe and Helpman (1995). This measure is formed as follows:

$$s^f_{m,i} = \sum (M_{ij} / M_i) s^d_j \quad (j \neq i) \quad (\text{A-1})$$

where M_{ij}/M_i is the percentage of Country i 's total trade that is conducted with Country j . S^d_j is each country's corresponding domestic R&D stock. Thus, the greater their trade share with Country j , the more influence they receive from j 's R&D. For this paper, these variables are reconstructed using the same equations as the previous authors; however, bilateral trade shares in capital goods are used rather than total goods.

Finally in regards to sample selection, in the productivity and domestic patenting regressions, a modified trade-embodied foreign spillover variable from Coe and Helpman (1985) ending in 1990 is included; therefore, the data range is limited to 1981 to 1990. On the contrary, because the trade-embodied foreign spillover variable is not used in the

foreign patenting equation, we are not restricted to pre-1990 data; thus, we choose to implement a more recent data set. Particularly for non-OECD countries, the consistency and completeness of recent data is significantly better than older data.

Throughout the paper, the selection of non-OECD countries is based on data completeness, and is uniform in each model. These countries include: Chile, Colombia, Guatemala, India, Iran, Israel, South Korea, Mexico, Philippines, Poland, Sri Lanka, Turkey, Venezuela, Zambia, and Zimbabwe.

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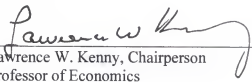
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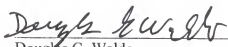
BIOGRAPHICAL SKETCH

Eric P. Chiang pursued his graduate work in Economics at the University of Florida. His research interests are in the area of intellectual property rights and international technology transfer. During his graduate career, Mr. Chiang held numerous teaching and research roles. He taught formal undergraduate courses in Game Theory. He served as a teaching assistant for Open-Economy Macroeconomics at the MBA level; and for undergraduate courses in Principles of Economics, Intermediate Microeconomics, Managerial Economics, International Trade, International Macroeconomics, Environmental Economics, and Labor Economics. His teaching experience extends beyond the classroom. Since 1999 he has co-taught an Economics session for the World Bank/PURC International Training Program for Utility Regulators. In addition, for four years he has served as head Economics tutor for the University of Florida Athletic Program. His research roles involved positions at the Center for International Business Education and Research, the Public Utility Research Center, the Bureau of Economic and Business Research, and research assistant positions with University of Florida faculty. Before arriving at the University of Florida in 1997, Mr. Chiang received a B.A. in Economics with *summa cum laude* honors at the University of Nevada, Las Vegas.

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